Volume 21, Number 4 February 28, 1967

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 4634 and 5505.

4433 (ANL-7125, pp 241-3) ANALYTICAL RESEARCH AND DEVELOPMENT. Larsen, R. P.; Meyer, R. J. (Argonne National Lab., Ill.).

A program for the development of analytical methods for the determination of burnup of fast reactor fuels and for the measurement of fast fission yields is being carried out. The determination of total rare earths is being considered as a means of measuring burnup. Using a complexiometric titration with ethylenediaminetetraacetic acid, 500 μg of rare earths have been determined with an accuracy of ±0.5%. At the 50-μg level, the accuracy is ±2%. The use of neutron activation for determining the fast fission yield of praseodymium-141 and other stable fission nuclides is also being investigated. Preliminary results indicate that this measurement can be made with an accuracy of ±1%. (auth)

4434 (IDO-14678) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter January 1–March 31, 1966. Maeck, William J.; Lisman, Frederick L.; Rein, James E. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1966. Contract AT(10-1)-205. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements were made of the α (capture-to-fission ratio) for U-233 and U-235. Two capsules containing a known amount of highly enriched U-235 and four capsules containing a known amount of highly enriched U-233 were irradiated in the MTR and subsequently analyzed for total and isotopic uranium concentration. Based on these data, tentative effective $\hat{\alpha}$ values (at a Cd ratio for Co = 15) and the computed 2200 m/sec values are: 0.0997 ± 0.0016 and 0.0984 ± 0.0016 for U-233, and 0.1768 ± 0.0015 and 0.1716 ± 0.0015 for U-235, respectively. (auth)

4435 (NP-16396) THE DETERMINATION OF ZIRCONIUM, NIOBIUM, AND HAFNIUM IN LOW ALLOY STEELS BY X-RAY SPECTROGRAPHY. Reed, Dorothy J. (Department of Mines and Technical Surveys (Canada). Mines Branch). Dec. 1965. 27p. (R-174). Dep. mn. Dept. of Mines and Technical Surveys, Ottawa $0.75.

Zirconium, niobium, and hafnium were determined in mild steels by x-ray spectrography in amounts up to 0.35, 0.30, and 0.20%, respectively, with errors of less than ±0.01%. Because suitable standards for zirconium and niobium were unavailable and no standards for hafnium existed, it was necessary to use synthetic standards. A number of samples were set up as Mines Branch secondary standards and the validity of their use was verified. Using accelerating potentials of 80 or 90 kV, zirconium and niobium may be determined in the ppM range. The sensitivity for hafnium is 0.01%. (auth)

4436 (ORNL-P-2690) FORENSIC APPLICATIONS OF TRACE ELEMENTS IN HAIR. Bate, L. C.; Dyer, F. F. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 18p. (CONF-660937-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Forensic Activation Analysis, San Diego, Calif.

Factors affecting identification in the analysis of hair for trace elements in criminal cases and methods for eliminating these factors are discussed. Recommendations are given concerning further studies on hair comparisons. (P.C.H.)

4437 (UCRL-17071) INVESTIGATION OF THE OXYGEN AND CARBON CONTAMINATION OF SOME LANTHANIDE AND ACTINIDE METALS. Lowenhaupt, Edward Harris (California Univ., Berkeley. Lawrence Radiation Lab.). May 5, 1965. Contract W-7405-eng-48. 58p. DTIE.

Thesis.

An activation analysis technique employing ^{3}He-induced nuclear reactions was used in a study of the oxygen and carbon contents of some lanthanide and actinide metals. Experimental application of the technique was refined. Its reliability within the limits of oxygen concentration encountered in this study was investigated, and an approximation, which introduced errors of greater than 50% in some cases in the calculation of results, was eliminated. The oxygen and carbon content of metals produced by reduction of their respective trifluorides with barium vapor was studied to determine the ability of some drying techniques to remove these elements from the trifluorides. Metals produced from untreated trifluorides contain about 6000 ppM oxygen. Metals produced from trifluorides treated with anhydrous HF gas were found to contain as little as 300 to 400 ppM oxygen. (auth)

4438 (UCRL-50115) GRAPHICAL REPRESENTATIONS OF SELECTED FUNCTIONS OF INTERPLANAR SPACINGS FOR 5184 INORGANIC X-RAY POWDER DIFFRACTION PATTERNS. Nichols, Monte C. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 4, 1966. Contract W-7405-eng-48. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Graphical representations of the distributions of strong d-spacings for 5184 inorganic mineral and nonmineral x-ray powder diffraction patterns are given. The bimodal character exhibited by some of the distributions is discussed. The usefulness and limitations of the Hanawalt scheme for identification using the ASTM file are discussed in the light of the distributions presented. The method of the inverse match (comparison of standard patterns with an unknown pattern, rather than unknown pattern with standard patterns) and its application to computer search techniques are discussed. (auth)

4439 (UCRL-70056) CATHODIC ETCHING TO PREPARE METALS FOR OXYGEN DETERMINATION. Hill, John H.; Morris, C. J.; Frazer, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 18, 1966. Contract W-7405-eng-48. 7p. (CONF-661008-1). DTIE.

From 1st Materials Research Symposium on Trace Characterization: Chemical and Physical, Gaithersburg, Md.

A cathodic etching method was developed to clean the surfaces of metal samples prior to oxygen determinations. The sample becomes the cathode in a low pressure argon-ion discharge. Argon ions bombard the surface of the sample and remove the oxide film by an etching process. The oxygen content of metal samples cleaned by cathodic etching is consistently lower than the oxygen content of samples cleaned by filing. In addition, contamination from radioactive samples is minimized because the sputtered metal deposits on surfaces inside the etcher assembly. (auth)

4440 (Y-KG-36) HIGHLIGHTS OF THE Y-12 BIOANALYSIS LABORATORY OPERATION. Kent, R. H. (Oak Ridge National Lab., Tenn.). Oct. 10, 1966. Contract W-7405-eng-26. 9p. (CONF-661018-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 12th Annual Bioassay and Analytical Chemistry Meeting, Gatlinburg, Tenn.

Procedures are described for the determination of enriched uranium, mercury, and ^{210}Po in human urine on a large scale. The procedures generally are economical and involve only a short time. (P.C.H.)

4441 (ZFK-RCH-3) AKTIVIERUNGSANALYTISCHES KOLLOQUIUM, 10.-13. MAI 1965 IN ROSSENDORF. (KURZFASSUNGEN DER VORTRAEGE UND DISKUSSION). (Activation Analysis Colloquium, May 10-13, 1965, in Rossendorf. Short Summaries of the Reports and Discussions). (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany). Deutsches Akademie der Wissenschaften zu Berlin (East Germany)). Dec. 1965. 27p. (In German). (CONF-650579-). Dep. mn.

Summaries are presented of the 26 reports given at the Activation Analysis Colloquium. These included: a review on the development of activation analysis, use of radioisotopes in analytical chemistry, determination of various elements in different materials, use of activation analysis in criminal investigations, system of automatic activation analysis with a neutron generator, application of the NA-1 neutron generator, boron determination in Si and Ge by proton and deuteron activation, oxygen determination on surfaces by triton activation, pneumatic fast irradiation installation for activation analysis, techniques of activation analysis with short-lived isotopes, determination limits in activation analysis, the sum coincidence method in activation analysis, selective activation in neutron activation analysis, and perturbations in the activation analysis by reactions with fast reactor neutrons. (P.C.H.)

4442 DETERMINATION OF ADSORPTION OF BARIUM IONS ON BARIUM SULFATE BY MEANS OF RADIOACTIVE ISOTOPES. Chursin, V. N.; Babeshkin, A. M.; Zaborenko, K. B. Radiokhimiya, 8: 404-10(1966). (In Russian).

New methods for determining the adsorption of similar ions on barium sulfate using radioactive isotopes are proposed. The dependence of adsorption size on the concentration of barium ions in the solution was established. It was found that the magnitude of adsorption on surface units depends on the structure and character of the surface of the barium sulfate crystals. Under the conditions studied, the formation of mixed crystals of barium sulfate with barium chloride in the solid solutions does not take place. (tr-auth)

4443 DIRECT METHOD FOR DETERMINING SMALL QUANTITIES OF RADON IN NATURAL WATERS BY MEANS OF PRELIMINARY CONCENTRATION ON ACTIVATED CARBON. Drozhzhin, V. M.; Nikolaev, D. S.; Lazarev, K. F.; Efimova, E. I.; Nechai, G. N. Radiokhimiya, 8: 442-9(1966). (In Russian).

A field method for the direct determination of small quantities of radon (10^{-13} to 10^{-15} Ci/l) in natural waters is reported. The method consists of blowing radon from large volumes of water (10 to 100 l) with air currents and with preliminary concentration of radon from the air current on activated carbon. By means of the proposed method the concentrations of radon in one water sample from the surface of the Black Sea was determined as 1.8×10^{-14} Ci/l. (tr-auth)

4444 RAPID URANIUM DETERMINATION IN SULFATE SOLUTIONS. Palei, P. N.; Nemodruk, A. A.; Deberdeeva, R. Yu. Radiokhimiya, 8: 437-41(1966). (In Russian).

The extraction of uranium with 20% solutions of TBP and diisoamyl ester of methylphosphinic acid was investigated as a function of the concentration of SO_4^{2-} and NO_3^-. It was found that uranium can be completely extracted from sulfate solutions by the addition of sufficient quantities of nitrate. A rapid photometric method for the determination of small quantities of uranium in sulfate solutions was developed. The method includes extraction with 20% solutions of TBP or diisoamyl ester of methylphosphinic acid after the addition of mixtures of the nitrates of aluminum and sodium and reextraction with solutions of sodium tartrate. In the reextract obtained, uranium is determined with Arsenazo III in 6 $\underline{M}$ HNO_3. The sensitivity of the method is 5 μg uranium in samples with volume up to 25 ml. The error is 5 to 10%, and time for the analysis is only 8 to 10 min. (tr-auth)

4445 STUDIES IN THE SEPARATION AND DETERMINATION OF ZIRCONIUM USING VANILLIN AS AN ANALYTICAL REAGENT. Jain, B. D.; Singh, J. J. (Univ. of Delhi). Proc. Indian Acad. Sci., Sect. A, 64: 182-4(Sept. 1966).

Vanillin, quantitatively precipitates zirconium between pH 5.0 and 6.5, as an insoluble complex. This complex on ignition gives ZrO_2, which can be weighed. Zirconium can be readily separated and determined in the presence of varying quantities of chromium (III), cobalt (II), copper (II), manganese (II), molybdenum (VI), nickel (II), titanium (IV), tungsten (VI), uranium (VI), vanadium (V), zinc (II), and trivalent rare earths. (auth)

4446 A QUICK METHOD FOR DETERMINING ^{90}Sr IN BIOLOGICAL MATERIAL AND WATER. Biheller, J. H. (Bundesstaatliche Bakteriologisch-Serologische Untersuchungsanstalt, Graz). Atompraxis, 12: 465-7(Sept. 1966). (In German).

A rapid method for determining ^{90}Sr in samples of biological material is described. It is based on the separation of ^{90}Y by means of alternating precipitation with oxalic acid and ammonium hydroxide. Detailed directions for the procedure are given. (tr-auth)

4447 DETERMINATION OF Mg BY ACTIVATION WITH TRITONS PRODUCED IN A NUCLEAR REACTOR AS A RESULT OF THE ACTION OF NEUTRONS OF LITHIUM FLUORIDE. Pauly, Jules; Sabbioni, Enrico; Girardi, Francesco (EURATOM, Ispra, Italy). Compt. Rend., Ser. C 263: 870-1(Oct. 10, 1966). (In French).

Mg was determined by incorporating the sample to be analyzed in a lithium fluoride tablet and irradiating it in a reactor. The tritons obtained by the ^{6}Li(n,α)^{3}H reaction react with the Mg to give ^{28}Mg. After chemical separation the radioactive Mg is measured by γ spectrometry using a semiconductor detector or a NaI(Tl) crystal. The detection limit for the determination is 0.2 μg. (tr-auth)

4448 MICROANALYSIS USED FOR METEORITES. Duval, Clement (Laboratoire de Recherches Micro-Analytiques, Paris). Chim. Anal. (Paris), 48: 537-48(Oct. 1966). (In French).

Results of determinations of the lesser components found in meteorites are given and some generalities, description, frequency of fall, and classification of meteorites discussed. The data were obtained by mass spectrography, the dilution method, and neutron activation. (auth)

4449 APPLICATION OF SELENIUM DIOXIDE IN THE DETERMINATION OF VARIOUS METALS. Agarwal, R. P.; Ghosh, Sami Kumar (Univ. of Allahabad, India). Chim. Anal. (Paris), 48: 555-8(Oct. 1966). (In French).

An aqueous solution of selenium dioxide was used as precipitant in the determination of ceric cerium, thorium, uranium, zinc, cadmium, and barium. (auth)

4450 NEW SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF TECHNETIUM WITH 1,5-DIPHENYLCARBAZIDE. Fujinaga, Taitiro; Koyama, Mutsuo; Kanchiku, Yoshihiko (Kyoto Univ.). Nippon Kagaku Zasshi, 87: 1243-4 (Nov. 1966). (In Japanese).

A new method was developed to determine Tc(VII) spectrophotometrically with 1,5-diphenylcarbazide (DPC) in HCl solution. Twenty minutes were required for the maximum development of color. The maximum absorption occurs at 558 mμ with the molar extinction coefficient of 26400. (J.G.B.)

4451 DETERMINATION OF OXYGEN IN ALUMINUM BY A FAST NEUTRON ACTIVATION METHOD. Fujii, Isao (Toshiba Central Research Lab., Kawasaki, Japan); Takada, Koichi; Muto, Haruo. Bunseki Kagaku, 15: 1239-45(Nov. 1966). (In Japanese).

A fast neutron activation method was applied to the determination of oxygen in aluminum and its alloys. A pre-treatment method of sample surface before analysis, optimum conditions on the measurement of gamma rays from ^{16}N, and a correction method for the absorption of neutrons, beta rays, and gamma rays in the sample are discussed. The samples including oxygen of the order of 10 to 0.0008% were analyzed by the proposed method. Relative standard deviations of the method in the oxygen levels of 0.1, 0.01, and 0.001% were 3, 5, and 30%, respectively. The sensitivity obtained was 2000 counts/mg of oxygen. (auth)

4452 A TRIAL METHOD OF DETERMINING URANIUM AND THORIUM CONTENT IN ROCKS BY THE RADIOACTIVE MEASUREMENTS. II. Nishimura, Susumu; Hatuda, Zinichiro; Asayama, Testuji (Univ. of Osaka Prefecture. Kyoto Univ.). Radioisotopes (Tokyo), 15: 289-94(1966). (In Japanese).

For the purpose of finding a proper method for studying radioactive disequilibrium of samples, the methods using a radioscope, alpha-scintillation counter, and gamma spectrometer were reexamined. As a result, the combination of gamma spectrometry with alpha counting with a scintillation counter was found to be appropriate for the purpose. (P.C.H.)

4453 DETERMINATION OF SULFUR CONTENT IN FUEL OIL BASED ON CONSTANT VOLUME METHOD BY X-RAY ABSORPTION OF TRITIUM BREMSSTRAHLUNG. Noguchi, Nobuhiko; Nomura, Masataka (Tokyo Electric Power Co., Inc.). Radioisotopes (Tokyo), 15: 301-9(1966). (In Japanese).

An x-ray absorption method by bremsstrahlung from a tritium–zirconium source (2.5 Ci) was studied as a rapid method for the estimation of sulfur content in fuel oil. The intensity of transmitted radiation was measured by means of a Geiger Müller counter and scaler. A constant volume method was adopted for calibration and a polypropyrene film ponch (50 μ in thickness) was used for a sample vessel. The sulfur content of the sample was calculated upon the correction procedures of density, temperature, and carbon–hydrogen mass ratio, and counting rates, by the x-ray counting rate of standard aluminum plate as well as by the β counting rate of a standard pure hydrocarbon, n-heptane. The carbon–hydrogen mass ratio of the sample was determined on the basis of a strontium-90 β radiation source (96 μCi) by the same basic apparatus. The results showed that the method is applicable for fuel oil containing up to 5% sulfur. The time required was around 10 to 15 minutes, including calculation. Accuracy was approximately 1.3 to 1.7% depending on sulfur content. (P.C.H.)

4454 A ^{99m}Tc GENERATOR USING HYDROUS ZIRCONIUM OXIDE. Pinajian, J. J. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotopes, 17: 664-6(Dec. 1966). (ORNL-P-2138).

In an effort to increase the capacity and specificity of the ^{99}Mo–^{99m}Tc generator system, the use of hydrous zirconium oxide/hydrochloric acid as an eluent was investigated. A standard chromatographic column containing hydrous zirconium oxide equilibrated with 0.01 M HCl was prepared. An acid solution of ^{99}Mo was charged on the column and the ^{99}Mo activity adsorbed on the exchanger. The system generated ^{99m}Tc which was eluted by acid 2-butanone, then determined with a γ spectrometer coupled to a 512-channel analyzer. ^{99}Mo content was also determined. Approximately 98% of the available ^{99m}Tc was eluted in 20 ml. (J.G.B.)

4455 NEW CATHODE TREATMENT FOR THE REPRODUCIBLE ELECTROLYTIC ENRICHMENT OF TRITIUM. Zutshi, P. K.; Sas-Hubicki, J. (IAEA, Vienna). Int. J. Appl. Radiat. Isotopes, 17: 670-1(Dec. 1966).

A method was developed for preparing phosphate-pickled steel cathodes to be used with stainless steel anodes in the electrolytic enrichment of tritium. The use of untreated cathodes in preliminary studies resulted in excessive rusting and corrosion at the cathodes and was associated with lack of reproducibility of tritium enrichment. Reproducibility with an error of ±3% was obtained between a series of 16 cells in the same run. Tritium recovery was 80%. (J.G.B.)

4456 THE DETERMINATION OF IODINE-CONTAINING COMPOUNDS BY NEUTRON ACTIVATION OF ^{129}I. Ouellette, R. P.; Balcius, J. F.; Zuppinger, K. (Massachusetts General Hospital, Boston). Int. J. Appl. Radiat. Isotopes, 17: 649-55 (Dec. 1966).

A method was developed for the determination of iodinated compounds in the blood sera. The method includes the following steps: labeling of the iodine pools with ^{129}I; paper chromatography in the n-butanol–acetic acid solvent system; neutron irradiation of the paper strips (^{129}I(n,γ)^{130}I); resin chromatography to remove impurities; and pulse height analysis. Sensitivity of the method is 10^{-11} g of iodine. Recovery is 99.9%. (auth)

4457 RADIOACTIVE CARBON DIOXIDE COUNTING BY A PLASTIC SCINTILLATOR CELL. Teshima, Hideo (Nagoya Univ., Japan). Radioisotopes (Tokyo), 15: 295-8(1966).

A strong memory effect was found after the measurement of $^{14}CO_2$ with a plastic phosphor counting cell. Experimental tests with thin strips showed that the residual radioactivity was due to the absorption of $^{14}CO_2$ into the plastic phosphor and desorption was diffusion controlled in the solid phase. A diffusion coefficient of 13.5×10^{-8} cm^2/sec was calculated from the experimental desorption data at 28°C. A new counting cell was designed based on the diffusion data. The counting rates of nine separate samples prepared from the same specific activity source were able to be reproduced to ±0.35%. This cell was successfully adapted to the counting of $^{14}CO_2$ in a self-diffusion study. (auth)

4458 APPLICATION OF SILVER NITRATE LABELLED WITH ^{110m}Ag FOR AUTORADIOGRAPHIC DETECTION OF FINGERPRINTS. Prokopowicz, Krystyna; Akerman, Karol; Szuchnik, Andrzej (Inst. of Nuclear Research, Warsaw). Int. J. Appl. Radiat. Isotopes, 17: 657-61(Dec. 1966).

Carrier solutions of 0.01N $AgNO_3$ labeled with ^{110m}Ag having maximal specific activity 2.0–2.5 μC/ml were used for detecting fingerprints by an autoradiographic method. An empirical equation was derived which gives the exact exposure time of the radioactive specimens on the photographic film to obtain the best autoradiographs. To calculate this exposure time, it is necessary to know the specific activity of the solution used, and to measure the counting rate in cpm of a 0.1 ml portion of the solution used and the investigated specimen under the same geometrical conditions. (auth)

4459 ESTIMATION OF MOISTURE CONTENT BY NEUTRON SCATTERING: THEORY, CALCULATION, AND EXPERIMENT. Gemmell, W.; McGregor, B.; Moss, G. F. (Australian Atomic Energy Commission, Lucas Heights. CSIRO, Melbourne). Int. J. Appl. Radiat. Isotopes, 17: 615-20(Dec.).

The moisture content of various cement products was determined, using a surface probe technique, and the results were interpreted using the Boltzmann transport equation, which was solved numerically on a digital computer in multi-energy group form. It was found that it is necessary to consider the density and type of all nuclei present in the materials under investigation in order that the technique may be described adequately. (auth)

4460 USE OF RADIOACTIVATION ANALYSIS FOR COPPER DETERMINATION IN VINE-GROWING AND IN VINE-PRODUCTS. Fourcy, A.; Dognin, J.; Faure, J.; Neuburger, M. (Centre d'Etudes Nucleaires, Grenoble, France). Int. J. Appl. Radiat. Isotopes, 17: 629-36(Dec. 1966). (In French).

Radioactivation analysis was used for the determination of trace-element and pesticide copper in vines. The amounts of copper present in the samples analyzed varied from 0.1 to 1000 μg. Two methods were used. The first one is for trace analysis and includes a radiochemical separation of copper, the other one is applicable to amounts above 100 ppM and is a purely instrumental method without chemistry. (J.G.B.)

4461 A COMPUTER PROGRAM FOR DOUBLE RADIONUCLIDE ASSAY DATA. Plotka, E. D.; Stant, E. G. Jr.; Waltz, F. A.; Garwood, V. A.; Erb, R. E. (Purdue Univ., Lafayette, Ind.). Int. J. Appl. Radiat. Isotopes, 17: 637-41(Dec. 1966).

A computer program was written in FORTRAN II and IV languages to calculate the amount of compound in a sample that was assayed by a double radionuclide derivative technique. The program will handle an unlimited number of sets of data with up to 200 samples per set. (auth)

4462 QUICK DETERMINATION OF OXYGEN IN STEEL BY FAST NEUTRON ACTIVATION. Shimura, Kazuteru (Fuji Iron and Steel Co., Ltd., Japan); Fujii, Isao. Tetsu To Hagane, 51: No. 11, 2178-80(Oct. 1965). (In Japanese).

Oxygen was determined in steel by activation analysis, and the result was compared with the value obtained by the vacuum fusion method. The time required for the determination was about one minute. The experimental results obtained by both methods were nearly the same. In the range of oxygen content 0.01 to 0.2%, the deviation was ±3 to 5% for forty measurements. The statistical deviation, at low oxygen contents, was inevitably somewhat large, but this may be reduced by improving the apparatus. In the sample preparation, cutting off a sample specimen after surface polishing gave a higher reliability in the measured value although it was more time-consuming. (NSA of Japan)

4463 DETERMINATION OF RADIOACTIVE IODINE IN PLANTS. Zaduban, Milan; Brutovskii, Milan; Liptakova, Gizela; Vinklerova, Olga (Inst. of Experimental Biology, Academy of Sciences, Kosice, Czech. Safarik Univ., Kosice, Czech.). Biologia, 21: 578-88(1966). (In Czech).

A method for measuring ^{131}I in plant tissues directly or after chemical treatment is described. Iodine–131 is detected with scintillation counters when no other radioisotopes are present in the sample, but when radioactive contaminants are present, iodine may be determined spectrometrically after chemical treatment. Iodine–131 is extracted from plant materials by NaOH at 100°C, an extraction that is improved by the application of ultrasonics. Precipitation, anion exchange, and chemical sorption are separation–concentration methods recommended. (TSS)

4464 SEPARATION AND IDENTIFICATION OF SOME THORIUM FISSION PRODUCTS BY ION EXCHANGE CHROMATOGRAPHY. Rizzardi, Giuseppe; Bertazzi, Nuccio (Univ., Padua. CNR, Padua). Ric. Sci., 36: 699-701(Aug. 1966). (In Italian).

The separation and identification of thorium fission products were carried out by chromatography on anion and cation exchange papers. (auth)

4465 USE OF TRIBUTYL PHOSPHATE FOR THE EXTRACTION OF MICROAMOUNTS OF CERIUM IN THE ANALYSIS OF STEELS. Eremin, Yu. G.; Raevskaya, V. V.; Romanov, P. N. (Polytechnical Inst., Volgograd. All-Union Scientific-Research and Design Inst., Volgograd). Zh. Anal. Khim., 21: 1303-6 (1966). (In Russian).

A method was developed for determining down to 0.005% of cerium in alloy steels. Cerium is separated by extraction with tributyl phosphate and coprecipitated as oxalate on lanthanum or calcium as a collector. Cesium is then determined by an extraction-photometric method by means of methylene blue. The relative experimental error of the determinations is 2 to 6%. (auth)

4466 A STUDY OF THE FLUORESCENT REACTION FOR TERBIUM WITH THE PHENYL ETHER OF SALICYLIC ACID. Kononenko, L. I.; Mishchenko, S. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim., 21: 1392-4(1966). (In Russian).

The phenyl ether of salicylic acid was used for the fluorometric determination of terbium. The method can be applied to the analysis of the concentrates of rare earth elements of the yttrium group. The method was tested on a number of samples of rare earth oxides. The mean experimental error was ±4.5%. (auth)

4467 PRODUCTION OF RADIOACTIVE STANDARDS FOR PAPER CHROMATOGRAPHIC SEPARATION. PART 2. SEPARATION OF ^{90}Sr AND ^{90}Y WITH THE HELP OF RING OVENS. Sorantin, H. (Technische Hochschule, Vienna). Mikrochim. Acta, No. 6, 957-64(1966). (In German).

The nuclide pair ^{90}Sr$-^{90}$Y was separated into its components on various kinds of paper in the ring furnace through various chemical separatory operations. The fastest separation occurred with 0.1 to 0.2N ammonium thiocyanate solution, the ^{90}Y being retained in the central portion of the paper disk while the ^{90}Sr was concentrated in the outer ring. A reversal was accomplished by sulfate precipitation or extraction with theonyltrifluoroacetone (TTA). In these cases the divalent ion remained in the center while the trivalent ion was washed into the ring. The separatory effect was detected autoradiographically through the decrease of the isolated ^{90}Y. The respective activity zones of the separated radio nuclide could be punched out and used as a relative standard. (auth)

4468 QUENCHING EFFECT FOR DETERMINATION OF TRITIUM AND ITS CHEMICAL ELIMINATION. Kainz, Gerald; Wachberger, Eugen (Univ., Vienna). Mikrochim. Acta, No. 6, 1032-8(1966). (In German).

The counting rate in the determination of tritium is distinctly lowered by certain combustion products that result during the oxidation of organic compounds. A reduction of this rate (quenching effect) occurs when halogens, NO_2, or SO_2 are present along with the radioactive water. The quenching effect is dependent on the amount of these combustion products and increases in the order: NO_2, bromine, SO_2, iodine. These products interfere even in the case of micro samples. To eliminate the quenching effect of the combustion products the interfering quenching compounds are precipitated by adding hydrazine hydrate. Difficultly soluble hydrazinium salts that separate in the crystalline condition are formed. (auth)

4469 ELECTROPHORESIS OF RARE EARTHS ON ACETYL CELLULOSE. II. STRIPS OF WIRE-LIKE CONSISTENCY AS CARRIER MATERIAL. Aitzetmueller, K.; Buchtela, K.; Grass, F.; Hecht, F. (Oesterreichische Hochschule, Vienna. Univ., Vienna). Mikrochim. Acta, No. 6, 1101-13(1966). (In German).

Studies on the electrophoretic separation of rare earth mixtures in α-hydroxyisobutyric acid was continued using cellogel strips and radioactive tracers. The purity and sequence were determined by γ-spectrometric analysis and the decay of the various activities. The detection of rare earths by direct activation of the electropherogram was carried out. Mixtures containing all the lanthanides were separated. (auth)

4470 NOMENCLATURE OF RADIONUCLIDES. Sorantin, H.; Muellner, P. (Reaktorzentrum, Seibersdorf, Austria). Mikrochim. Acta, No. 6, 1153-5(1966). (In German).

For reasons of expediency, with respect to the neutron activation analysis, a more extended division based on the half-lives is proposed, both of the natural and the artificial radionuclides. (auth)

4471 METHODS OF PREPARATION OF TISSUE SAMPLES FOR RADIOMETRY. Levitman, M. Kh. (Inst. of Industrial Hygiene and Occupational Diseases, Moscow). Radiobiologiya, 6: 325-6(1966). (In Russian).

A simple method for preparing bone tissue for radiometry is described in which crude purified bone is dissolved in nitric acid (50 mg/ml) and then diluted with distilled water (1 : 2) for use in thin- or thick-layer measurements. The technique is particularly useful in measuring radioisotopes that may produce volatile compounds under the effects of high temperature on bone. Validity of the method was tested in rats given $^{45}CaCl_2$ or $Na_2{}^{35}SO_4$. The best results were obtained in determinations of ^{35}S. (H.G.D.)

4472 DETERMINATION OF INORGANIC RADIO-IODIDES IN COMPOUNDS LABELED WITH ^{131}I BY THIN-LAYER-CHROMATOGRAPHY. Mitta, Aldo E. A.; Camin, Leopoldo L.; de Troparevsky, Maria L. P. (Comision Nacional de Energia Atomica, Buenos Aires). Radiochim. Acta, 6: 111-12(Oct. 1966).

Thin-layer chromatography was found to be satisfactory for determining inorganic radioiodides in ^{131}I-labeled organic compounds. Chromatograms were developed at room temperature and the location of spots carried out both chemically and by autoradiography. (M.C.G.)

4473 INVESTIGATION OF FRESH FALLOUT SAMPLES WITH Ge(Li) SEMICONDUCTOR COUNTERS. Kloes, H.; May, R.; Schneider, H. (Univ., Giessen, Ger.). Z. Naturforsch., 21a: 1502-4(Sept. 1966). (In German).

The γ spectrum of fresh fallout samples from the third Chinese nuclear tests was measured with the Ge(Li) semiconductor counter. The ratio of the ^{95}Zr lines at 723 and 757 keV was determined. The age of the samples was calculated from the zirconium–niobium activity ratio. (tr-auth)

4474 SEPARATION OF ACTINIDES BY HIGH-VOLTAGE ELECTROPHORESIS. Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 6: 62-4(Oct. 1966). (In German).

The electrophoretic separation of the actinides Ac, Am, and Cm from one another was performed successfully via α-hydroxyisobutyric acid as a means of propagation, at a voltage of about 90 volts/cm. Under the same working conditions the separation of a mixture of actinides and lanthanides was examined; the actinium was also separated from its decay products. The quantitative detection of the various elements was carried out by measuring the impulse rate on the electrophoresis band. The elements were identified by γ-spectroscopic measurements and by determining the half-lives. (auth)

4475 APPLICATIONS OF NEUTRON ACTIVATION ANALYSIS IN PLANT BIOLOGY AND AGRONOMY. Fourcy, A.; Fer, A.; Barbe, R.; Neuburger, M. (CEN, Grenoble, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-77/9, 18p. (In French). (CONF-660912-2). ORAU.

From FAO/IAEA Symposium on the Use of Isotopes in Plant Nutrition and Physiology Studies, Vienna.

Samples were activated in the neutron flux of a light water, pool-type reactor. The thermal flux ranged from 5×10^{12} to 2×10^{13} n cm^{-2} sec^{-1}. The radioactivity measurements were made with a 400 Cx γ-spectrometer, either directly on the irradiated sample (Mn, Cu, K), or after radiochemical separation (Cu, Co, Fe, Zn, Na, K, Rb, Cs, Ca, Sr, Ba, Sc, and La). The easiest chemical separation process is that involving ion-exchange resins, a technique which is suitable for automation. Spectrometric data can be used for accurate identification of the elements measured and can be analyzed by a computer. Various agronomical and radio-ecological applications are described. The list of substances measured is not limitative and can be extended, depending on the opportunities for performing radioactivation analysis and on the requirements of plant biology. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 4438.

4476 (AECL-2546) NEW MATERIALS FOR ION EXCHANGE. A LITERATURE SURVEY TO DECEMBER 1965. Hemmings, R. L. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Mar. 1966. 52p. Dep. mn. AECL $1.50.

A review is presented on the properties of various materials, such as coal and peat, clay and clay minerals, zeolites, shale, synthetic organic based materials, synthetic materials, and insoluble salts and oxides for use as ion exchange materials. The survey showed that most of them have properties (low cost, high capacity, unusual selectivity) that make them useful for treating waste solution from fuel reprocessing plants. Of those materials most suitable for high temperature water purification, zirconium phosphate and hydrous zirconium oxide seem to show the most promise. (125 references). (P.C.H.)

4477 (AERE-R-5220) PROPERTIES OF HYDRATED TITANIUM DIOXIDE AND HYDRATED TANTALUM PENTOXIDE AS HIGH TEMPERATURE ION EXCHANGE MATERIALS. Chidley, B. E.; Parker, F. L.; Talbot, E. A. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1966. 28p. Dep. BIS $0.90. HMSO 4s. 6d.

Hydrated titanium dioxide and hydrated tantalum pentoxide were examined for possible use as ion exchange materials at 300°C. After a few hours titania lost all its capacity: tantala retains a significant capacity, certainly up to 50 hours. (auth)

4478 (AGN-8202) ALKALI METALS EVALUATION PROGRAM. Quarterly Progress Report, July 1–September 30, 1966. Achener, P. Y. (Aerojet-General Nucleonics, San Ramon, Calif.). Nov. 1966. Contract AT(04-3)-368. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are reported for studies on thermodynamic and transport properties of Cs, Rb, Li, and Na. Studies were made on Li and Na for heat pipe applications. The properties measured include PVT relations, vapor thermal conductivity, liquid viscosity, vapor viscosity, and specific heat for Cs and Rb and vapor pressure, surface tension and contact angle of the liquid and its vapor, liquid and vapor viscosity, and specific heat for Na and Li. Data are tabulated. (P.C.H.)

4479 (ANL-7125, pp 119-49) MATERIALS CHEMISTRY AND THERMODYNAMICS. (Argonne National Lab., Ill.).

An updated phase diagram of the $U-UO_2$ system is given. Exploratory tests indicated that the liquid miscibility gap, which characterizes the $U-UO_2$ system at elevated temperatures, extends into the $U-UO_2-W$ system. The solubility of W in solid hypostoichiometric urania appears to be quite small, probably less than 1% up to 2500°C. Vapor pressure studies are also discussed. Special attention was given to the development of a fluidized-bed process for carburization of hydrided U–Pu alloy with CH_4-H gas mixtures to form (U,Pu)C. The results of thermodynamic calculations and corrosion studies are reported. Thermodynamic data using a fluorine bomb calorimeter were determined for BF_3, BN, ZrB_2, HfB_2, NbB_2, TaB_2, CF_4, PF_5, AsF_5, SF_6, SeF_6, TeF_6, and NiF_2. The nature of carbon and its compounds in liquid sodium was studied. An analytical procedure was developed for the determination of total C in Na. The partial pressure of monatomic Na over liquid Na was determined at about 140°C by the atomic absorption spectrophotometric method. The decomposition pressures of CeCd and PrCd were determined by the Knudsen effusion method. The activity coefficient of Pu present in dilute solution in liquid Mg was obtained by two different methods. Final results on the phase diagram and thermodynamic studies of the Cd-rich portion of the Pu–Cd system are reported, along with measurements on susceptibility of US–ThS solid solutions. (auth)

4480 (ANL-7125, pp 200-36) ENERGY CONVERSION. Crouthamel, C. E.; Hesson, J. C.; Tevebaugh, A. D.; Bingle, J. D. (Argonne National Lab., Ill.).

Investigations on regenerative electrochemical systems for the conversion of heat into electrical energy were continued. The program is divided between physical-chemical laboratory studies and engineering considerations. The physical-chemical laboratory studies included three major projects: lithium hydride cell studies; intermetallic cell studies; and liquid-vapor equilibrium studies on intermetallic systems. Extensive studies were made on electrolytes for a lithium hydride cell. Engineering studies were concerned mainly with the development of thermally regenerative emf cell systems of the bimetallic type. The density, viscosity, and surface tension of the NaF–NaCl–NaI molten salt eutectic, used as an electrolyte for cells with sodium anodes, were measured at temperatures up to 800°C. The densities of liquid Na–Bi and Na–Pb alloys at sodium concentrations up to 50 mole % were also measured at temperatures up to 800°C. The surface tension of Na–Bi alloys containing 30 to 50 mole % sodium was also measured. Experimental Na–Bi and Na–Pb apparatus were constructed and operated. (P.C.H.)

4481 (BNL-10727) FISSION PRODUCT BEHAVIOR IN SODIUM SYSTEMS. Castleman, A. W. Jr.; Tang, I. N.; Mackay, R. A. (Brookhaven National Lab., Upton, N. Y.). Nov. 2, 1966. Contract AT-30-2-GEN-16. 16p. (CONF-661110-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

In order to predict fission product behavior in Na, studies were made on the chemical potential of fission products in liquid Na, their volatility and the extent to which they would be released during the vaporization of Na, and their chemical state upon release to the vapor phase. The results of studies on the interactions of iodine and Cs in a Na environment are presented. The excess free energy of mixing of NaI in dilute sodium solutions was measured to be 9100 ± 400 cal/mole. Also included are the excess free energies of mixing for Sb, Ba, Cs, NaI, Rb, Sr, and Te calculated from existing phase diagrams. Activity coefficients, calculated from the excess free energy values, were combined with vapor pressure data and used to predict fission product vaporization as a function of sodium vaporization. (P.C.H.)

4482 (COO-505-13) CHEMICAL EQUILIBRIA AT HIGH TEMPERATURES AND THE MECHANISM OF VAPORIZATION OF COMPOUNDS. Progress Report for the Period October 26, 1965–October 29, 1966. Seifert, Ralph L. (Indiana Univ., Bloomington. Dept. of Chemistry). Oct. 29, 1966. Contract AT(11-1)-505. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The thermodynamic quantities, ΔG^0, ΔH^0, ΔS^0, and ΔC_p^0 were measured for AgCl, AgBr, AgI, LiCl, and LiBr from measurements of E^0 over a range of temperature for a reversible galvanic cell in which the cell reaction is the formation of the liquid salt from its constituent elements. The pulsed electrolysis, or electronic commutator, technique that was used produces the free halogen within the cell (more readily ensuring isothermal conditions) and permits monitoring the cell to detect overvoltage, depolarization effects, and proper functioning of the electrodes. Data are presented in graphical and tabular form. (P.C.H.)

4483 (COO-716-023) AN INVESTIGATION OF SOME RARE EARTH BORON, CARBON, NITROGEN, AND RELATED SYSTEMS AT ELEVATED TEMPERATURES. Technical Progress Report, February 1, 1966–January 31, 1967. Eick, Harry A. (Michigan State Univ., East Lansing. Dept. of Chemistry). Contract AT(11-1)-716. 64p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Results are reported for studies on: Ce–O–N system; crystal structure of $La_2(CO_3)_3 \cdot 8\,H_2O$; high temperature phase transition of lanthanol oxide fluorides; thermodynamics of vaporization of SmC_2; problems in congruency characterization of Nd_2O_2Te; preparation and properties of lanthanide oxide carbide phases; synthesis of SmF_2 by reduction of SmF_3 with Sm; effects of the crucible material on the congruency of evaporation of Nd_2O_2S; vaporization of YbC_2; and systems of mixed metal selenides. (P.C.H.)

4484 (COO-1142-71) [EFFECTS OF ISOTOPIC SUBSTITUTION ON RATES OF CHEMICAL REACTIONS]. Report for the Period, October 1, 1965–September 30, 1966. Yankwich, Peter E. (Illinois Univ., Urbana). Contract AT(11-1)-1142. 165p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Separate articles are included for studies on: isotope effects in gas-phase decomposition of deutero-oxalic acid; isotope effects in gas-phase decomposition of ordinary oxalic acid; anomalous temperature dependence of kinetic isotope effects; kinetics and deuterium isotope effects in the reaction of nitrogen dioxide and formic acid; electron gun performance using a modified appearance potential technique; and direct calculations of kinetic isotope effects, including variations of the reaction coordinate. Brief summaries are given of developments in studies on: carbon isotope effects in decomposition of oxalic acid in solution; carbon isotope effects in metal-ion oxidations of formic acid; kinetics and carbon isotope effects in the isomerization of cyclopropane; carbon isotope effects in the decompositions of malonic acid and hydrogen malonate ion; carbon isotope and stoichiometric effects in the pyrolysis of manganous oxalate, including variations with degree of decomposition; mass spectrometry of gas-phase decomposition of oxalic acid; and flash photolysis of formic acid vapor. (P.C.H.)

4485 (EGG-1183-2111) QUENCHING MEASUREMENTS ON ORGANIC SCINTILLATORS. Yates, E.; Crandall, D.; Kirkbride, J. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Nov. 1966. Contract AT(29-1)-1183. 11p. (CONF-660612-6; S-62-TN). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Organic Scintillators, Argonne, Ill.

The effects of oxygen and various organic compounds on quenching of toluene scintillators were studied in order to develop faster liquid organic scintillators having shorter decay times and a minimum of long-tail light output. In the experimental method used, the time distribution of the decay of the scintillation light emission was measured in the nanosecond range. Pulse heights were reduced in all cases; decay times and tail-to-peak ratios, however, increased in some cases but not others. Oxygen was found to be the best quencher of tail emission and piperidine was the best reducer of decay time. (P.C.H.)

4486 (INR-726/XIII/C) THE INFLUENCE OF SOME PARAMETERS ON THE CHEMICAL COMPOSITION OF THE AQUEOUS SOLUTIONS OF UNLABELLED AND ^{32}P LABELLED META AND PYRO PHOSPHORIC ACIDS. Zelenay, Krystyna; Pasternak, Antoni (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 15p. Dep.

The dependence of chemical changes in HPO_3 and $H_4P_2O_7$ solutions in course of time upon changes in dilution, pH, and temperature were investigated. Immediately after dilution the polymerization of ortho- to pyro- and poly-forms occurs, and then after a few hours the depolymerization begins, the latter being a general tendency in phosphoric acid solutions. The changes of poly- to ortho-form proceed through pyro-form. The changes are faster, the greater the dilution, lower pH, and higher temperature. No difference in behavior was observed between radioactive and inactive solutions. (auth)

4487 (N-66-31860) CHEMICAL REACTIONS OF CARBIDES, NITRIDES, AND DIBORIDES OF TITANIUM AND ZIRCONIUM AND CHEMICAL BONDING IN THESE COMPOUNDS. Philipp, Warren H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1966. 22p. CFSTI $3.00 cy, $0.65 mn.

Because the group IVA transition metal carbides, nitrides, and borides may possibly be used as high-temperature materials, their physical properties were investigated. The reactions of these refractories under study were investigated in various media, including chromic acid solution, hydrochloric acid, acidified hydrogen peroxide, fused potassium hydroxide, and solutions containing hydrofluoric acid. Semiquantitative analyses of the reaction products are presented, including mass-spectrometric determinations of evolved gases. Based on a comparison of the chemical properties of the group IVA carbides, nitrides, and borides with those of known bonding, the nature of the bonding is discussed. The hypothesis used assumes that the outer electrons of the nonmetal (carbon, nitrogen, boron) interact with the d orbitals of the transition metal atom. (auth)

4488 (UCRL-17147) ELECTRON TRANSFER IN WEAKLY IONIZED GASES. **Parks, Eric Keith** (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 103p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Two and three body recombination rates of the ions formed from the photolysis of thallium halide vapors are reported. The method used and experimental results are described, along with the current state of the theory as compared with the results. The rate constants based on the Thomson model for three body recombination were consistantly well below experimental results. The reasons for these discrepancies are discussed. (P.C.H.)

4489 (WANL-TME-1478) PARA-HYDROGEN CODES. **Pierce, B. L.** (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Aug. 15, 1966. Contract SNP-1. 60p. DTIE.

FORTRAN IV para-hydrogen property programs, which are modifications of Los Alamos Scientific Laboratory TAB Code, are described. Changes were made to the TAB Code to reduce computer storage requirements and to obtain continuous property values. Instructions in the use of the programs are provided. Tabulation of property values for para-hydrogen in the temperature range from 36 to 5000°R and pressure range from 14.7 to 2000 psia are included. (auth)

4490 (AEC-tr-6635) PROBLEMS IN THE STUDY OF RARE EARTHS. **Trifonov, D. N.** Translation of Problema Redkikh Zemel', Gosatomizdat, Moscow, 1962. 149p. (IPST-Cat.-1504). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Topics covered include: discovery of the "rare earth continent," from Mosander to Mendeleev, the "stumbling block" of the periodic system, Mendeleev and the rare earths, rare earth elements and their place in the periodic table, properties of rare earth elements, isotopes and radioactivity of rare earth elements, the problem of element No. 61, and some unsolved problems and practical applications of rare earth elements. (M.C.G.)

4491 (ORNL-tr-1413) SOLS OF HYDRATED THORIUM OXIDE AND THORIUM OXIDE. Translated by **R. G. Mansfield** (Oak Ridge National Lab., Tenn.), from pp 231-9 of Gmelin Handbook of Inorganic Chemistry, 8th Edition, Verlag Chemie Weinheim. 22p. Dep. mn. JCL $2.60 fs, $0.86 mf.

Methods of preparation of positive hydrated thorium oxide sols are reviewed. The nature and composition of the sols are considered along with coagulation by electrolysis, by mixtures of electrolytes, by nonelectrolytes, by other sols, and by ultraviolet radiation. The viscosity, osmotic pressure, sorption, optical properties, and electrochemical properties of the sols are described. Negative sols of hydrated thorium oxide are also considered. Metathorium oxide sols are discussed. (M.C.G.)

4492 COMPLEX EMANATION-THERMAL INVESTIGATION OF THE NITRATE AND SULFATE OF THORIUM. **Tetner, R.; Zaborenko, K. B.** Radiokhimiya, 8: 485-9(1966). (In Russian).

The complex emanation-thermal method was applied to the study of the crystal hydrates of thorium nitrate and sulfate. From the polytherm of the emanation, the regions of dehydration and decomposition were found and the diverse character of the thorium oxides obtained was established. The transition of the thorium metaoxide into the normal oxide was observed. It was confirmed that the decomposition of thorium nitrate proceeds through the basic nitrate. Consecutive investigation of the evolution of thoron from solids was done by the scheme polytherm-isotherm-polytherm. The polytherm of the emanation reflects all transition states of the structure of the solids during annealing. (tr-auth)

4493 RADIOCOLLOIDS IN SORPTION SYSTEMS. V. EFFECTS OF NEUTRAL COMPLEX FORMING SALTS. **Egorov, Yu. V.; Lyubimov, A. S.; Nikolaev, V. M.; Khrustalev, B. N.** Radiokhimiya, 8: 397-404(1966). (In Russian).

The desorption isotherm with a hyperbolic form, connecting the size of the gross distribution of the radiocolloids with the quantity introduced in the sorption system of complex-forming substances, was proposed. Approximate results of the isotherm investigated were analyzed. The behavior of the radiocolloids ^{91}Y and ^{106}Ru in sorption systems (vermiculite and activated manganese dioxide) was investigated in the presence of complex-forming substances (EDTA). (tr-auth)

4494 INVESTIGATION OF THE PRECIPITATION MECHANISM OF ^{231}Pa AND ^{230}Th FROM OCEAN WATER. **Kuznetsov, Yu. V.; Elizarova, A. N.; Frenklikh, M. S.** Radiokhimiya, 8: 459-68(1966). (In Russian).

Studies showed that the content of ^{231}Pa and ^{230}Th differs in different types of precipitates. The greatest concentration was detected in red deep-water clays: ^{231}Pa was 3.7 to 8.8×10^{-11} g/g and ^{230}Th was 2.18 to 6.57×10^{-9} g/g. It was established with an increase in the concentration of Fe, Mn, fractions <0.001 mm, and the size of the precipitate surface, and with decrease of the concentration of biogenic components ($CaCO_3$ and amorphous SiO_2) the concentration of ^{231}Pa and ^{230}Th in the precipitate increases. From the results obtained it follows that ^{231}Pa and ^{230}Th in ocean water will be identical. Both elements can probably be removed from ocean precipitates by sorption methods. (tr-auth)

4495 DIALKYL PHOSPHATE COMPLEXES OF RARE EARTH ELEMENTS AND THORIUM. **Sinyavskaya, E. I.; Sheka, Z. A.** Radiokhimiya, 8: 410-16(1966). (In Russian).

Stability constants of the complexes $ThOHA^{2+}$, LaA^{2+}, NdA^{2+}, and YbA^{2+} with dimethyl-, diethyl-, dipropyl-, and diamylphosphates (A^- = anions of dialkylphosphate) were determined. The correlation of the stability constants of the complexes according to the Taphta equation was done by means of the value of the constant σ^* for alkyl radicals of the dialkylphosphates investigated. It was found that the reaction of the complex formation of the rare earths and thorium with dialkylphosphoric acids is very sensitive to the effects of substitutions to the radicals; spatial factors play no role in the processes studied. (tr-auth)

4496 POTENTIOMETRIC INVESTIGATION OF THE EQUILIBRIUM OF Pu(IV)-CITRATE IN AQUEOUS SOLUTION. **Nebel, Dieter** (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Z. Phys. Chem. (Leipzig), 232: 368-76(1966). (In German).

Potentiometric measurements were carried out for the control of a series of spectrophotometric studies on the equilibrium of Pu(IV)-citrate. The following complex constants for the system Pu^{4+}-citrate using pH titrations and redox potential measurements were found: $K_1 = 6.9 \times 10^{15}$ (pH titration) or 3.5×10^{15} (redox potential) and $K_2 = 1 \times 10^{29}$ (pH titration) or 1×10^{30} (redox potential). (tr-auth)

4497 PRODUCTION OF OXYGEN COMPOUNDS OF XENON BY β DECAY OF IODINE ISOTOPES AND STUDY OF THEIR PROPERTIES. **Murin, A. N.; Kirin, I. S.; Nefedov, V. D.; Grachev, S. A.; Gusev, Yu. K.; Ivannikova, N. V.; Gusel'nikov, V. S.** Radiokhimiya, 8: 449-54(1966). (In Russian).

The possibility of using chemical transformations during β decay of iodine isotopes for the synthesis of radioactive xenon trioxide was studied. A method was developed for the investigation of xenon compounds that were formed during the β decay of ^{131}I and ^{133}I as potassium iodate and periodate. (tr-auth)

4498 ISOTOPIC EXCHANGE OF O(^1D) WITH CARBON DIOXIDE. **Baulch, D. L.; Breckenridge, W. H.** (Univ. of Leeds, Eng.). Trans. Faraday Soc., 62: 2768-73(Oct. 1966).

The photolysis of carbon dioxide with xenon resonance radiation (1470 Å) was used as a source of excited atomic oxygen O(^1D). The exchange and quenching reactions of O(^1D) with carbon dioxide were investigated by measuring the rate of growth of $C^{16}O^{18}O$ in a photolyzed mixture of $C^{16}O^{16}O$ and $C^{18}O^{18}O$. The probability αN of incorporation of each O(^1D) into a CO_2 molecule before quenching can occur is 0.69. Possible interpretations of this result are discussed. The simplest explanation of the exchange kinetics is provided by the intermediate formation of CO_3. This species must be sufficiently long lived for internal energy equilibration to take place. (auth)

4499 INTERACTION OF NITROGEN WITH TANTALUM. **Gasser, R. P. H.; Lawrence, C. P.; Newman, D. G.** (Physical Chemistry Lab., Oxford). Trans. Faraday Soc., 62: 2916-21 (Oct. 1966).

The adsorption of nitrogen by tantalum occurs with a maximum sticking probability of 0.22, which is independent of pressure and temperature between 4×10^{-8} and 4×10^{-7} torr and between 296 and 530°K. At temperatures above 900°K rapid absorption occurs. The efficiency of tantalum as a catalyst for the isotope exchange reaction $^{28}N_2 + {}^{30}N_2 = 2\,{}^{29}N_2$ increases with increases in temperature and in uptake of nitrogen. (auth)

4500 KINETICS OF HYDROGEN AND DEUTERIUM ATOM ABSTRACTION BY METHYL RADICALS FROM HYDRAZINES AND SUBSTITUTED HYDRAZINES. **Gray, Peter; Herod, A. A.; Jones, A.; Thynne, J. C. J.** (Univ. of Leeds, Eng.). Trans. Faraday Soc.. 62: 2774-84(Oct. 1966).

The reactions of methyl radicals with seven substituted and deuterated hydrazines were investigated and values for the velocity constant and Arrhenius parameters of hydrogen abstraction were obtained. The positions of attack on dimethyl hydrazines, and the size of the kinetic isotope effects in abstraction from N–H bonds, were derived from experiments using deuterium-substituted compounds. Kinetic isotope effects (k_H/k_D, etc.) were substantially in accord with expectations based on zero-point-energy differences. The general patterns of reactivity were similar to those found in related isoelectronic and homologous compounds. (auth)

4501 FRAGMENTATION OF ALKYL KETONES BY ELECTRON IMPACT AND ITS THEORETICAL EXPLANATION. Hirota, Kozo; Hatada, Motoyoshi. Sci. Pap. Inst. Phys. Chem. Res. (Tokyo), 60: 78-84(Sept. 1966).

Scission probability of C–C bonds of nine alkyl ketones by electron impact was determined from the mass spectra by comparing their spectra with those of corresponding deuterated ketones. The result can be explained satisfactorily by the electron density of the highest level of LCBO–MO (linear combination of bond orbital–molecular orbital) at the bonds, without introducing any arbitrary constant. (auth)

4502 THE BEHAVIOR AND STRUCTURE OF URANYL NITRATE IN ORGANIC SOLVENTS. IV. INVESTIGATIONS OF URANYL NITRATE DIHYDRATE IN ALCOHOLS BY CONDUCTIVITY. Ernst, S.; Jezowska-Trzebiatowska, B. (Wroclaw Univ. Inst. of Physical Chemistry, Wroclaw). J. Inorg. Nucl. Chem., 28: 2885-7(Dec. 1966).

Investigations were made of uranyl nitrate in methanol and ethanol. The first stage of dissociation was assumed to be $UO_2(NO_3)_2 \rightarrow UO_2NO_3^+ + NO_3^-$ and the results were analyzed by the Fuoss-Kraus method. Limiting molar conductances, Λ_0(mole), and association constants, K_A, are reported together with free energies of dissociation, ΔG, and ion sizes, a_B. The dihydrate, like the anhydrous and hexahydrate forms, is weakly dissociated in alcohol solutions. (auth)

4503 CALORIMETRIC DETERMINATION OF ENTHALPY OF HYDRATION OF UO_3. Drobnic, M.; Kolar, D. (Nuclear Inst. Josef Stefan, Ljubljana, Yugoslavia). J. Inorg. Nucl. Chem., 28: 2833-5(Dec. 1966).

A highly reactive amorphous UO_3 powder with a specific surface area of 30 m^2/g was prepared and its enthalpy of hydration was measured directly in the microcalorimeter at 25°C. The results are strongly dependent on the proper heat treatment of the sample. The correct value was found to be 32.0 ± 0.1 kcal/mole. The direct method could be applied to other measurements of the enthalpy of hydration. (auth)

4504 EQUILIBRIUM OXYGEN PRESSURES OVER THE NONSTOICHEIOMETRIC URANIUM OXIDES UO_{2+x} AND U_3O_{8-x} AT HIGHER TEMPERATURES. Hagemark, K.; Broli, M. (Technical Univ. of Norway, Trondheim). J. Inorg. Nucl. Chem., 28: 2837-50(Dec. 1966).

By use of a thermobalance the nonstoichiometry in the phases UO_{2+x} and U_3O_{8-x} was determined as a function of the partial oxygen pressure at 900 to 1500°C. Values for the partial free enthalpy of oxygen, as well as the enthalpy and entropy are given. Except at compositions for O/U less than 2.01, the agreement with adopted values in the phase UO_{2+x} was excellent. However, data for the phase U_3O_{8-x} did not confirm the previously assessed partial thermodynamic quantities. The values obtained for the phase boundaries were consistent with values accepted in the literature. A quasi-theoretical relation between the oxygen pressure and nonstoichiometry was derived. (auth)

4505 THERMAL EXPANSION COEFFICIENTS OF THE ANHYDROUS TRICHLORIDES OF CERIUM, PLUTONIUM, AND AMERICIUM. Fuger, J. (Univ. of California, Berkeley). J. Inorg. Nucl. Chem., 28: 3066-9(Dec. 1966). (UCRL–16352).

Thermal expansion coefficients of the trichlorides of Ce, Pu, and Am were calculated from powder diffraction patterns between room temperature and a temperature close to the melting point of the compounds. Results are presented in tables. Plots of lattice parameters vs. temperature were linear within the accuracy of the measurements. (M.C.G.)

4506 THE SOLUTION ABSORPTION SPECTRUM OF Cf^{3+}. Conway, J. G. (Univ. of California, Berkeley); Fried, S.; Latimer, R. M.; McLaughlin, R.; Gutmacher, R. G.; Carnall, W. T.; Fields, P. J. Inorg. Nucl. Chem., 28: 3064-6(Dec. 1966). (UCRL–16971).

The solution absorption spectrum of californium in the trivalent state was investigated. Various concentrations of $CfCl_3$ in DCl and $DClO_4$ were investigated. Deuterated solvents were used to increase the range over which the near infrared spectral region could be investigated. Isotopically the californium was ~80% ^{252}Cf and ~20% ^{254}Cf. Energy release from the decay caused bubbling in the cells, which blocked the light path. Individual runs never exceeded 2 min. Repeated runs, all of which were superimposed on a constantly increasing absorption background, were required. (M.C.G.)

4507 HYDROLYSIS OF U=O GROUPS IN URANYL FLUORIDE AND THE POSSIBLE EXISTENCE OF OTHER FLUORO-OXIDES OF URANIUM. Midgley, A.; Phillips, T. R.; Hamlin, A. G. (United Kingdom Atomic Energy Authority, Chester, Eng.). J. Inorg. Nucl. Chem., 28: 3047-51(Dec. 1966).

Use of sulfur tetrafluoride to determine the degree of hydration of films of uranyl fluoride showed that the fluoride always appeared to have a higher water content (10.3%) as determined by using sulfur tetrafluoride than as determined by loss in weight at 150°C (8.6%). The results are explained by assuming that in hydrated uranyl fluoride part of the U=O groups are converted to $U(OH)_2$ groupings. The overall reaction is postulated as: $UO_{2-y}(OH)_{2y}F_2 \cdot (x - y)H_2O + (x + y)SF_4 \rightarrow UO_{2-y}F_{2+2y} + (x + y)SOF_2 + 2xHF$. (M.C.G.)

4508 THE COMPLEXING POWER OF HYDROXAMIC ACIDS AND ITS EFFECT ON BEHAVIOR OF ORGANIC EXTRACTANTS IN THE REPROCESSING OF IRRADIATED FUELS. II. THE COMPLEXES BETWEEN BENZOHYDROXAMIC ACID AND THROIUM, URANIUM(IV) AND PLUTONIUM(IV). Barocas, A.; Baroncelli, F.; Biondi, G. B.; Grossi, G. (CNEN, Rome). J. Inorg. Nucl. Chem., 28: 2961-7(Dec. 1966).

Values of the stability constants of the complexes of benzohydroxamic acid with Th^{4+}, and Pu^{4+} were determined. At pH = 0 the hydroxamic function showed a complexing power only with respect to plutonium. A comparison between the values of the stability constants related to other ions present in fission products mixtures, confirmed the specificity of the hydroxamic function towards zirconium in strongly acidic solutions. (auth)

4509 ISOTOPIC EFFECT OF THE CATALYTIC DISCHARGE OF HYDROGEN IN THE PRESENCE OF Co. Calusaru, Aurelian; Kuta, Jaroslav (Institut de Polarographie Jaroslav Heyrovsky, Prague). Compt. Rend., Ser. C, 263: 841-3(Oct. 10, 1966). (In French).

A strong isotopic effect was found during the catalytic discharge of H_2 from NH_4Cl-NH_4OH systems in the presence of Co. The effect of the concentration of cysteine on the height of the catalytic waves, corresponding to discharge of hydrogen and of deuterium in the presence of Co was determined. The curves were similar but the values corresponding to deuterium were much lower. In the region where the curves tend toward the limiting value characteristic of catalytic currents, the current corresponding to the hydrogen discharge was 3.36 times greater than that corresponding to the deuterium discharge. Gelatin decreased the height of the catalytic waves. The effect of the substitution of hydrogen by deuterium is explained by considering the differences between the velocities of protonization and deuteration. (J.S.R.)

4510 THE ELECTRON EXCHANGE REACTION BETWEEN URANIUM(VI) AND TIN(II) IN ETHANOL–WATER MEDIA. Tan, Z. C. Ho; Amis, E. S. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 28: 2889-2903(Dec. 1966). (ORO–2069–56).

The electron exchange reaction between uranium (VI) and tin (II) was studied at 25, 35, and 45°C in water, 20.0, 40.0, 60.0, 80.0, and 99.9 wt % ethanol–water mixtures. In each solvent the reaction was studied in 1, 2, 4, and 6M hydrochloric acid. The reaction was found to be first order with respect to uranium (VI), first order with respect to tin (II), and second order overall. The second order rate equation was obeyed to different percentages of completion of reaction in different compositions of ethanol and hydrochloric acid. In most cases second order kinetics were followed up to about 60 to 90 per cent completion of the reaction, though in higher percentages of alcohols and lower hydrochloric acid concentrations second order rates were observed for a few runs up to lower percentages completion, about 40 to 60% completion. (auth)

4511 ABSORPTION SPECTRA OF NEPTUNIUM IONS IN PERCHLORIC ACID SOLUTION. Hagan, P. G.; Cleveland, J. M. (Dow Chemical Co., Golden, Colo.). J. Inorg. Nucl. Chem., 28: 2905-9(Dec. 1966).

The absorption spectra of neptunium (III), (IV), (V), and (VI) in 2 molar perchloric acid were measured in the wavelength region from 400 to 1400 mμ. Novel procedures are described for the preparation of neptunium (III) and (VI). (auth)

4512 MECHANISMS OF SUBSTITUTION REACTIONS AT SULFINYL SULFUR. II. CONCOMITANT ELECTROPHILIC AND NUCLEOPHILIC CATALYSIS OF THE SOLVOLYSIS OF ARYL SULFINYL SULFONES IN ACETIC ACID–WATER.

Kice, John L.; Guaraldi, Giancarlo (Oregon State Univ., Corvallis). J. Amer. Chem. Soc., 88: 5236-41(Nov. 20, 1966).

In acetic acid–1% water the rate of acid-catalyzed solvolysis of aryl sulfinyl sulfones (II) was rather dramatically accelerated by the addition of small amounts of various alkyl sulfides. The sulfide-catalyzed solvolysis is first order in both sulfide and sulfinyl sulfone; its rate is proportional to the Hammett acidity function and is strongly dependent on the structure of the sulfide ($\rho^* = -1.6$). Electron-withdrawing substituents in the aromatic ring attached to the sulfonyl sulfur of II enhance the rate of reaction with a given sulfide while the same substituents in the ring attached to the sulfinyl sulfur retard the reaction somewhat. The reaction shows a small solvent isotope effect, $k_H/k_D = 1.15$. Several mechanisms which are consistent with these data are presented. In each of them one has a nucleophilic attack by the sulfide on the sulfinyl group of II, which displaces the $ArSO_2$ group; this displacement is significantly assisted by the transfer of a proton to the departing $ArSO_2$ group. The mechanisms differ only in the details of how this proton transfer is effected. The sulfide-catalyzed solvolysis of II is thus an example of concomitant nucleophilic and electrophilic catalysis of the scission of a sulfur–sulfur bond involving substitution at sulfinyl sulfur. It is compared with earlier examples of such catalysis involving substitution at sulfenyl sulfur. (auth)

4513 MECHANISM OF THE ACID HYDROLYSIS OF SODIUM ARYL SULFATES. **Kice, John L.; Anderson, James M.** (Oregon State Univ., Corvallis). J. Amer. Chem. Soc., 88: 5242-5(Nov. 20, 1966).

The solvent isotope effect ($k_{D_2O}/k_{H_2O} = 2.43$), the dependence of rate on acidity ($\log k_\phi = -H_0 + \text{constant}$), and the effect on the rate of changing per cent dioxane in dioxane–water mixtures were determined for the acid-catalyzed hydrolysis of sodium phenyl sulfate. The results are compared with the corresponding data for the hydrolysis of sodium methyl selenate, a reaction which is known to proceed via an A-2 type mechanism. The comparison strongly indicates that the hydrolysis of the aryl sulfate ion involves the A-1 type mechanism. An explanation of how the observed effect of Ar group structure on rate of hydrolysis of $ArOSO_3^-$ can be accommodated to this mechanism is presented. (auth)

4514 THE MECHANISM OF THE ACID HYDROLYSIS OF BUNTE SALTS (S-ALKYL AND S-ARYL THIOSULFATES). **Kice, John L.; Anderson, James M.; Pawlowski, Norman E.** (Oregon State Univ., Corvallis). J. Amer. Chem. Soc., 88: 5245-50(Nov. 20, 1966).

The rates of acid-catalyzed hydrolysis of a series of S-aryl and S-alkyl thiosulfates (Bunte salts) were measured under a variety of reaction conditions in water and various dioxane–water mixtures. The data on the variation of the hydrolysis rate with the acidity of the medium and on the increase in rate accompanying an increase in the dioxane content of dioxane–water mixtures were compared with corresponding data for two closely related acid-catalyzed hydrolyses: that of sodium aryl sulfates (a reaction thought to proceed by an A-1 mechanism), and that of sodium methyl selenate (a reaction presumably proceeding by an A-2 mechanism). This comparison shows that the response of the Bunte salt hydrolysis to these particular reaction variables is very closely comparable to that of the sulfate hydrolysis and very different from that of the selenate hydrolysis, and it strongly suggests that the Bunte salt hydrolysis proceeds by an A-1 mechanism. It was found that the observed solvent isotope effect for the Bunte salt hydrolysis ($k_{D_2O}/k_{H_2O} = 1.4$) and the variation of rate with Ar for $ArSSO_3^-$ ($\rho \cong -0.5$) are also compatible with the particular A-1 mechanism shown in eq. 3. This mechanism involves an initial reversible protonation of the Bunte salt on the divalent sulfur followed by rate-determining unimolecular dissociation of the zwitterion intermediate to thiol and sulfur trioxide. It is thus the same type of mechanism proposed for the sulfate hydrolysis. A tentative explanation is advanced to explain why the Bunte salt and sulfate hydrolyses, although proceeding by the same basic mechanism, showed somewhat different response of rate to changes in alkyl or aryl group structure. (auth)

4515 CHEMICAL SHIFTS OF ^{11}B IN ICOSAHEDRAL CARBORANES. **Boer, F. P.** (Dow Chemical Co., Wayland, Mass.); **Hegstrom, R. A.; Newton, M. D.; Potenza, J. A.; Lipscomb W. N.** J. Amer. Chem. Soc., 88: 5340-2(Nov. 20, 1966).

Probable paramagnetic contributions to the ^{11}B shift in three icosahedral carboranes, *o*-, *m*-, and *p*-$B_{10}C_2H_{12}$ were calculated. Electrons in the 2p orbitals, both for the nucleus under consideration and for bonds to all other atoms, were included. Diamagnetic contributions were estimated. Results showed that boron chemical shifts in the icosahedral carboranes can be satisfactorily explained on the basis of a difference primarily in the paramagnetic shielding of boron atoms in different chemical environments. (J.G.B.)

4516 LOW-TEMPERATURE KINETICS IN PROTIC SOLVENTS. REACTIONS OF p-NITROPHENYL ACETATE IN METHANOL AND METHANOL-d AT -78 DEG. **Menger, F. M.** (Emory Univ., Atlanta). J. Amer. Chem. Soc., 88: 5356-7 (Nov. 10, 1966).

The kinetics of the reactions of methoxide ions or *n*-butylamine with *p*-nitrophenyl acetate (*p*-NPA) in methanol or methanol-*d* at −78.2°C were investigated. Vapor phase chromatography was used for analysis of the reaction products. The reaction rate of the methoxide ion with *p*-NPA in methanol-*d* was 2.6 times that in methanol. The aminolysis of *p*-NPA proceeded only 1.12 times faster in methanol-*d*, a rate difference which approaches the size of the experimental error. Reaction mechanisms are proposed. (J.G.B.)

4517 STUDY ON THE DOUBLE OXIDES OF Nb OR OF Ta AND OF A LANTHANIDE; RESPECTIVE DIFFERENTIATIONS OF THESE ELEMENTS. **Chretien, Andre; Bodiot, Daniel** (Sorbonne, Chaire de Chimie Minerale, Paris). Compt. Rend., Ser. C, 263: 882-4(Oct. 10, 1966). (In French).

Two double oxides of Nb or Ta and of a lanthanide element M were prepared in the solid state at approximately 1,000°C and identified. The types were different for Nb(MNb_5O_{14}) and Ta (MTa_7O_{19}). The first type, relatively stable thermally, was obtained only with La, Ce, and Pr; on heating a mixture of hemipentoxide Nb_2O_5 and double oxide MNb_3O_9 are formed, except for the La compounds. $LaNb_5O_{14}$ is fusible and recrystallizes after fusion at 1,310°C. The second type is formed by Nd, Sm, and Gd in addition to La, Ce, and Pr. The type MTa_7O_{19} remains solid up to 1,500°C at least. (tr-auth)

4518 STUDY BY INFRARED SPECTROSCOPY OF ALKALINE EARTH AMIDES. **Bouclier, Patrick; Novak, Alexandre; Portier, Josik; Hagenmuller, Paul** (Faculte des Sciences, Bordeaux. CNRS, Thiais, France). Compt. Rend., Ser. C, 263: 875-8(Oct. 10, 1966). (In French).

The infared spectra from 4,000 to 200 cm^{-1} of $Ca(NH_2)_2$, $Ca(ND_2)_2$, $Sr(NH_2)_2$, and $Ba(NH_2)_2$ were studied in the solid state. The doubling of the bands due to internal vibrations of the NH_2^- and ND_2^- was interpreted by crystal effects. A correlation between the μ(NH) frequencies and the cation lines is suggested. A free rotation of the NH_2^- ion in the crystal does not seem possible. (tr-auth)

4519 DEUTERIUM–HYDROGEN EXCHANGE IN A cis-LACTAM AMIDE GROUP. **Klotz, Irving M.; Feldelseit, Philip L.** (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc., 88: 5103-5(Nov. 20, 1966).

Rates of deuterium–hydrogen exchange were measured for 2-pyrrolidone (II) at 11.0 and 19.5°C, and compared with values for two *trans* amides, *N*-methyl- and *N*-ethylacetamide. The *cis* amide showed markedly faster exchange rates, a higher activation energy, and a larger entropy of activation. The amide nitrogen seemed more accessible in the *cis* amide but the energy for placing a D^+ on it was greater. (auth)

4520 SPECTROPHOTOMETRIC STUDY OF TRIVALENT ACTINIDE COMPLEXES IN SOLUTION. II. NEPTUNIUM AND PLUTONIUM. **Shiloh, M.; Marcus, Y.** (Israel Atomic Energy Commission, Yavne). J. Inorg. Nucl. Chem., 28: 2725-32(Nov. 1966).

Spectra of neptunium (III) and plutonium (III) were studied in aqueous halide solutions as functions of the halide concentration. Each element was found to exhibit strong absorption at a characteristic wavelength in concentrated lithium chloride or bromide solutions. In chloride solutions neptunium and plutonium have intense absorption bands at 26,050 and 32,050 cm^{-1} respectively, and in bromide solutions the bands are shifted about 250 cm^{-1} towards lower energies. These bands are attributed to $5f^n \rightarrow 5f^{n-1}\,6d^1$ transitions. The stability of the complexes MX_2^+ could be estimated, being the same, within experimental error for both M = Np and M = Pu, the values for the effective constants β_2 being $(1.0 \pm 0.1) \times 10^{-5}\ M^{-2}$ for X = Cl and $(3.1 \pm 0.4) \times 10^{-7}\ M^{-2}$ for X = Br. At intermediate halide concentrations, the species MX^{2+} are formed. The stability of these complexes are much lower than those of solvent shared ion pairs of these elements, as is the case with uranium (III). (auth)

4521 ISOTOPIC EXCHANGE BETWEEN PRECIPITATED ANTIMONY OXIDE AND ANTIMONY IONS IN AQUEOUS SOLUTION. **Qureshi, I. H.; Shabbir, M.** (Atomic Energy Center, Lahore). J. Inorg. Nucl. Chem., 28: 2603-8(Nov. 1966).

Heterogeneous isotopic exchange between freshly precipitated antimony oxide and antimony ions in aqueous solution was studied at different temperatures. The temperature had a marked influence on the exchange reaction, which appeared to be composed of two main processes, adsorption and self-diffusion. The rate constants and apparent activation energies for the two processes were determined. (auth)

4522 OXIDATION OF URANIUM TETRACHLORIDE. Kanellakopulos, B.; Parthey, H. (Nuclear Research Center, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 28: 2541-9(Nov. 1966).

The oxidation of uranium tetrachloride was investigated by thermo-analytical and x-ray diffraction methods. It proceeds in the presence of oxygen at atmospheric pressure via uranyl chloride (UO_2Cl_2) as an intermediate product: $UCl_4 + O_2 \rightarrow UO_2Cl_2$ and $3UO_2Cl_2 + O_2 \rightarrow U_3O_8 + 3Cl_2$. The conversion at the surface of the crystal initially set the rate. The activation energy and the frequency factor of the surface reaction were calculated. After a coat of reaction products had grown the diffusion of oxygen through the interface controlled the continued oxidation process. The thermal decomposition of uranyl chloride becomes noticeable from 400°C on, accelerating the reaction at reduced pressure and causing a change in the kinetics. (auth)

4523 CHEMISTRY OF THE CHLORINE TRIFLUORIDE–URANYL FLUORIDE REACTION. Shrewsberry, R. C.; Williamson, E. L. (Union Carbide Corp., Paducah, Ky.). J. Inorg. Nucl. Chem., 28: 2535-9(Nov. 1966). (TID–22656).

The reaction of chlorine trifluoride (ClF_3) with uranyl fluoride (UO_2F_2) was studied from 77 to 165°C and its stoichiometry found to be represented by the equation: $2ClF_3 + UO_2F_2 \rightarrow ClO_2F + ClF + UF_6$. The reaction was complicated by slower secondary reactions involving the chloryl fluoride (ClO_2F) and chlorine monofluoride (ClF) in the products. These reactions are $ClO_2F \rightarrow ClF + O_2$ and $4ClF + UO_2F_2 \rightarrow O_2 + 2Cl_2 + UF_6$. At the higher temperature and/or long reaction times, when these secondary reactions are complete, the stoichiometry of the $ClF_3-UO_2F_2$ reaction is then best represented by the equation: $4ClF_3 + 3UO_2F_2 \rightarrow 3O_2 + 2Cl_2 + 3UF_6$. (auth)

4524 HOMOMOLECULAR EXCHANGE OF OXYGEN ISOTOPES AT HIGH TEMPERATURES. Shakhashiri, B. Z.; Gordon, G. (Univ. of Maryland, College Park). Contract AT(40-1)-2858. J. Inorg. Nucl. Chem., 28: 2525-8(Nov. 1966).

The homomolecular exchange reaction of oxygen isotopes between molecular species of oxygen: $^{16}O_2 + {}^{18}O_2 = 2[^{16}O^{18}O]$ was investigated from 685 to 750°C. Below 100 torr, the rate of exchange was found to be second order with respect to the total oxygen pressure which suggests the formation of an $[O_4]$ species for the exchange reaction. The rate of the reaction increased with an increase in the surface to volume ratio of the quartz reaction vessel. The activation enthalpy was 47.8 kcal/mole and the activation entropy was –37 e.u. (auth)

4525 STUDY OF THE SOLUTION CHEMISTRY OF TECHNETIUM IN HYDROCHLORIC ACID AT VARIOUS TEMPERATURES BY PAPER AND ION EXCHANGE CHROMATOGRAPHY. Shukla, Shyama Kant (Univ., Rome. CNR, Rome). Ric. Sci., 36: 725-8(Aug. 1966).

The reduction of the pertechnetate ion by concentrated hydrochloric acid was studied at 0, 8, 23 and 100°C. Practically pure Te(V) was obtained in concentrated HCl at 0°C. It was stable at this temperature for a period of 3 months. (auth)

4526 APPLICATION OF RADIOISOTOPES IN POLAROGRAPHY. NOTE V. POLAROGRAPHIC BEHAVIOR OF THORIUM SALT SOLUTIONS USING ^{228}Th AS TRACER. Naldi, Enrico; Busulini, Loris (CNR, Bologna. CNR, Padua). Ric. Sci., 36: 707-11(Aug. 1966). (In Italian).

The polarographic behavior of thorium was studied using Th–228. The radiopolarograms showed the presence of two reductive processes at potential values more negative than the discharge of the supporting electrolyte. The first process (at –2.15 V, vs S.C.E.) was attributed to Ra–224 and the second (at –2.65 V, vs S.C.E.) to the thorium. The presence of the second wave was found in solutions having a particular composition. (auth)

4527 ATOMIC PARAMETERS AND MAGNETIC STRUCTURE OF $UCrO_4$. Bacmann, M.; Bertaut, E.-F.; Bassi, G. (CEN, Grenoble, France). Bull. Soc. Franc. Mineral. Crist., 88: 214-8 (Apr.-June 1965). (In French).

Neutron diffraction was used to define the octahedral coordinates of Cr and U in orthohombic $UCrO_4$ ($a = 4.47_1$, $b = 11.78_7$, and $c = 5.05_3$ Å in the group Pbcn). Cr is in the trivalent state and U in the pentavalent state. The magnetic neutron diffraction at 4.2°K shows an antiferromagnetic arrangement with the negative bonds Cr–Cr and Cr–O–U. The values observed of the spins $S(Cr) = 1.20 \pm 0.05$ and $S(U) = 0.15 \pm 0.02$ are considerably reduced by covalence effects with respect to the theoretical values of spin $S(Cr^{3+}) = 3/2$ and $S(U^{5+}) = 1/2$. (tr-auth)

4528 VAPOR PRESSURE OF SCANDIUM AND YTTRIUM RARE EARTH METALS. Kruglykh, A. A.; Pavlov, V. S. Izv. Akad. Nauk SSSR, Metal., No. 1, 178-89(Jan.-Feb. 1966). (In Russian).

Data on the vapor pressure of the rare earth metals are compiled. Measurements are reported for samarium, gadolinium, dysprosium, erbium, ytterbium, and yttrium. (tr-auth)

4529 THE CRYSTAL STRUCTURE OF $LiUF_5$. Brunton, George (Oak Ridge National Lab., Tenn.). Acta Crystallogr., 21: 814-17(Nov. 10, 1966). (ORNL-P–1991).

The compound $LiUF_5$ crystallizes in space group $I4_1/a$ with unit cell parameters $a_0 = 14.884$, $c_0 = 6.547$ Å. The x-ray density is 6.23 g-cm^{-3} and $Z = 16$. The U^{4+}, Li^+, and $5F^-$ ions occur in positions 16(f). Twenty-one positional parameters, six anisotropic uranium temperature factors, and six isotropic temperature factors were determined from 739 independent reflections measured by the 2θ-scan technique with a scintillometer. The parameters were refined by least squares to an R value of 0.072. Absorption corrections were made for an oblate spheroid with a short 55.8μ axis, [110], and a 74.4μ diameter for the circular section containing [110] and [001]. The absorption factor μR was 4.16 in the direction of maximum absorption. The U^{4+} ion has $9F^-$ nearest neighbors with bond distances of 2.26 to 2.59 Å. The F^- ions are at the corners of a 14-faced polyhedron which has the form of a triangular prism with pyramids on each of the three prism faces. The Li^+ ion has $6F^-$ nearest neighbors with bond distances of 1.84 to 2.31 Å. These F^- ions are at the corners of an irregular octahedron. (auth)

4530 THE COMPLEX COMPOUNDS BETWEEN l-ASCORBIC ACID AND THE METAL IONS. I. COMPLEXES OF U, Co, Ni, Mn, AND Zn IN THE ACID MEDIUM. Veselinovic, Dragan S.; Susic, Milenko V. (Inst. of Physical Chemistry, Belgrade. Inst. of Chemistry, Tech., and Metallurgy, Belgrade). Glas. Hem. Drustva Beograd, 30: 63-77(1965). (In Serbian).

Investigations of the reactions between l-ascorbic acid and Mn^{2+}, UO_2^{2+}, Co^{2+}, Ni^{2+}, and Zn^{2+} ions, respectively, by the method of continual variation with use of pH-metric measurements, showed that these ions form cationic complexes of the type $[MeA]^+$ (Me-bivalent metal ion; A^--anion of monobasic l-ascorbic acid). Dissociation constants of these complexes for the ionic strength $\mu = 0$ at 25°C were determined: pK = 3.04 (U); pK = 1.4 (Co); pK = 1.05 (Ni); pK = 1.1 (Mn); pK = 1.0 (Zn). (auth)

4531 MAGNETIC PROPERTIES OF URANIUM BISMUTHIDES. Trzebiatowski, W.; Zygmunt, A. (Technical Univ., Wroclaw. Inst. of Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 495-7(1966).

Studies showed the uranium bismuthides to be paramagnetic. At low temperatures they exhibit the same kind of magnetic order as other uranium compounds with Group V elements. U_3Bi_4 is ferromagnetic, whereas UBi and UBi_2 are antiferromagnetic. The magnetic behavior of UBi is related to the cooling rate. Comparison of the magnetic properties of UBi with NdBi confirmed that the exchange interaction occurring in the uranium compounds is much stronger than in the lanthanide series as indicated by their Néel point and Weiss constant (NdBi: $T_N = 24°$; $\theta = -1$). (P.C.H.)

4532 MEASUREMENT OF SMALL SELF-DIFFUSION COEFFICIENTS OF ANIONS IN SILVER CHLORIDE BY THE SURFACE METHOD WITH THE HELP OF THE ABSORPTION BEHAVIOR OF THIN MATERIAL LAYERS FOR β RADIATION. Grunau, H.; Noelting, J. (Univ., Goettingen, Ger.). Z. Phys. Chem. (Frankfurt), 51: 150-4(Nov. 1966). (In German).

An evaluation process for the surface method was developed. It is based on the absorption and scattering behavior of thin layers of material for β^- radiation. By this method the self-diffusion of anions in fused bodies of silver chloride was measured at 250 to 375°C. The temperature dependence of the diffusion coefficient can be described by the following expression: $D = 670 \exp(-39500 \pm 1500/RT)$ cm^2 sec^{-1}. (tr-auth)

4533 ISOTOPE EFFECTS IN ORGANIC CHEMISTRY ANL BIOCHEMISTRY. Simon, H.; Palm, D. (Technische Hochschule, Munich). Angew. Chem. Int. Ed. Engl., 5: 920-33(Nov. 1966).

The extent to which isotope effects are likely to be encountered in the use of isotope techniques and what problems are studied with primary and secondary isotope effects are considered. By way of example, the results of studies on E2 reactions, particularly in the Hofmann degradation, are discussed, followed by a discussion of some "analytical isotope effects". The problems encountered and the information that can be obtained from isotope effect studies on enzyme reactions, and the advantages and disadvantages of competitive and noncompetitive techniques are described. In addition to a survey of isotope effects in dehydrogenase reactions, isotope effects encountered in the dehydrogenation of T-labeled alcohols are reported. (auth)

4534 MEASUREMENT OF THE ISOTOPE EFFECT ON EQUILIBRIUM DURING THE ABSORPTION OF HYDROGEN ON A PALLADIUM–PLATINUM ALLOY DISPERSED ON ITS SUPPORT. Botter, Fernande; Menes, Janine; Charpin, Pierrette; Dirian, Gregoire (CEN, Saclay, France). J. Chim. Phys., 63: 1367-74(Oct. 1966). (In French).

The isotopic equilibrium factor $\alpha = (D/H)_{gas}/(D/H)_{soln}$ was measured between hydrogen gas at atmospheric pressure and hydrogen dissolved in a homogeneous 10 mole per cent platinum–palladium alloy, dispersed on porous sintered α alumina. The absorbant material was obtained by reduction of a mixture of both metal chlorides deposited on the alumina carrier. X-ray examination and hydrogen sorption isotherms showed that platinum and palladium were present on the carrier as a homogeneous alloy. Equilibrium constants of the reactions involved were calculated. (J.G.B.)

4535 CRYSTAL STRUCTURE OF NIOBIUM MONOXIDE. Bowman, A. L.; Wallace, T. C.; Yarnell, J. L.; Wenzel, R. G. (Los Alamos Scientific Lab., N. Mex.). Acta Crystallogr., 21: 843(Nov. 10, 1966). (LA-DC-7979).

X-ray diffraction data give a lattice constant of 4.2101 ± 0.0003 A for NbO. Comparison of observed and calculated neutron diffraction intensities confirm the previously assigned oxygen positions 3(d)(½00; 0½0; 00½). (D.L.C.)

4536 TRANSITION TEMPERATURE OF SUPERCONDUCTING TECHNETIUM–TUNGSTEN ALLOYS. Trojnar, E.; Niemiec, J. (Inst. of Physics, Wroclaw. Inst. of Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 565-7 (1966).

The transition temperature and upper critical fields of some Tc–W alloys containing 15 to 97.5 at. % Tc were measured. The critical temperature was determined by measuring the flux trapped in the superconducting sample after removal of the external field. The transition temperature, which was measured to within ±2°K, increased initially as the atomic percentage of Tc was raised, attained a maximum of 10.4°K at 90 at. % of Tc, and decreased at still higher Tc contents. (P.C.H.)

4537 Th_3N_4 CRYSTAL STRUCTURE AND COMPARISON WITH THAT OF Th_2N_2O. Benz, Robert (Los Alamos Scientific Lab., N. Mex.); Zachariasen, W. H. Acta Crystallogr., 21: 838-40(Nov. 10, 1966). (LA-DC-7965(Rev.)).

Th_3N_4 was prepared by equilibration of ThN powder in 0.13 atm N_2 at 1320°. Th_2N_2O was prepared by equilibration of compacted $3ThN + ThO_2$ in 2 atm N_2 at 1700°C, and its x-ray diffraction pattern shows it to be the same as the Th_2N_3 reported by Zachariasen (Acta Cryst. 2: 388 (1949)). X-ray diffraction data for Th_3N_4 correspond to a rhombohedral lattice with $a_0 = 9.398 \pm 0.002$ A, $\alpha = 23.78 \pm 0.01°$; and a hexagonal cell with $a_0 = 3.871 \pm 0.001$, $c_0 = 27.385 \pm 0.005$ A. Its space group is $R\bar{3}m$, and its structure is closely related to that of Th_2N_2O. (D.L.C.)

4538 STATE OF RADIOTRACER ZIRCONIUM IN THE PRESENCE OF PHENYLARSONIC ACID IN NITRIC ACID. Kyrs, M.; Selucky, P.; Pistek, P. (Nuclear Research Inst., Rez, Czech.). Radiochim. Acta, 6: 72-5(Oct. 1966).

Experiments on the adsorption, centrifugation, dialysis, and electrolysis of zirconium solutions containing 0.075M phenylarsonic acid were carried out. The behavior of zirconium can be characterized as "radiocolloidal." The formation of "pure" radiocolloids rather than "pseudoradiocolloids" can account for the results obtained. The nature of the species of zirconium involved is discussed. (auth)

4539 TETRAFTORID URANA. (Uranium Tetrafluoride). Gagarinskii, Yu. V.; Khripin, L. A. Moscow, Atomizdat, 1966. 232p.

A brief review is given on the preparation and properties of uranium tetrafluoride. A critical analysis is made of published data on the chemical and physical properties of UF_4, its crystal hydrates, and its binary salts. Thermodynamic properties, crystal structure, and chemical bonds of uranium tetrafluoride are described. The nature of tetrafluoride crystal hydrates and their dehydration products, the binary and ternary systems formed by UF_4 with other halides are discussed and phase diagrams of these systems are constructed and analyzed. (238 references.) (R.V.J.)

4540 THERMODYNAMICS OF CERTAIN REFRACTORY COMPOUNDS. VOLUME I. DISCUSSION OF THEORETICAL STUDIES. SECTIONS I-VI. Schick, Harold L. New York, Academic Press, 1966. 678p.

This publication is based on ASD-TR-61-260(Pt.II).

The techniques used to analyze thermodynamic data for refractory borides, carbides, nitrides, and oxides of metallic elements are summarized, and detailed data analyses for all the refractories considered are given. (P.C.H.)

Radiation and Nuclear Chemistry

Refer also to abstract 5505.

4541 (AD-637657) ISOTOPE EFFECT IN THE DISSOCIATIVE ATTACHMENT IN H_2 AT LOW ENERGY. Schulz, G. J.; Asundi, R. K. (Westinghouse Research Labs., Pittsburgh, Pa.). Aug. 15, 1966. Contract Nonr-2584(00). 24p. (TR-33). CFSTI $3.00 cy, $0.65 mn.

The dissociative attachment cross section for formation of H^- and D^- from H_2, HD, and D_2 was measured in the threshold range from 3.75 to 5 eV using a mass spectrometer for ion identification. A pronounced isotope effect was observed. The cross section of H^- from H_2 had a peak value of 1.6×10^{-21} cm², D^- from HD, 1×10^{-22} cm², and D^- from D_2, 8×10^{-24} cm², all peaks occuring at 3.75 eV. Negative ion formation in this energy range proceeded via the compound state, whose lifetime against autodetachment was calculated from the cross sections to be about 1×10^{-15} sec. Because of this short lifetime and the relatively long time needed for the atoms to separate, the probability of survival of the negative ion and therefore the dissociative attachment cross section in H_2 at 3.75 eV was small. For the heavier isotopes the separation time was even longer and therefore the dissociative attachment cross section was minute. The same compound state was also responsible for vibrational excitation of the hydrogen molecule. (auth)

4542 (RPI-321-9) SOME STUDIES OF THE IONIZING RADIATION INDUCED ISOTOPE EXCHANGE IN GASEOUS NITROGEN. Progress Report. Brown, R. D.; Dondes, S.; Harteck, P. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Chemistry). Oct. 1966. Contract AT(30-3)-321. 167p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The gas phase isotopic exchange of $^{14}N_2$ with $^{15}N_2$ under ionizing radiation has been studied in a number of systems important to the ionizing radiation induced fixation of nitrogen. A limited number of experiments were done at temperatures greater than the ambient temperature of the Brookhaven National Laboratory Graphite Research Reactor. Some experiments were also performed using a ^{60}Co source and some utilizing the fission products of ^{235}U. The results indicate that a mixture of $^{14}N_2$ and $^{15}N_2$ free of oxygen or other impurities undergoes isotopic exchange to form $^{14}N^{15}N$ with a G_N value of 11.5 ± 1.0. The mechanisms of this isotopic exchange are believed to be the random recombination of nitrogen and a type of molecular exchange. Experiments in which oxygen was added to the isotopic nitrogen mixture showed a decrease in G_N with increasing concentration of oxygen. It appears that the primary role of oxygen is to remove nitrogen ions from the system by charge transfer thus preventing nitrogen atoms from forming as a result of ion recombination. Oxygen also appears to quench excited nitrogen molecules. Experiments were conducted using mixtures of either ^{15}NO or $^{15}NO_2$ in isotopically natural nitrogen. G_N was found to be 2.0 to 2.6. Similarly conducted experiments in which isotopically natural nitric oxide or nitrogen dioxide was added to a mixture of 'N_2 and $^{15}N_2$ showed G values 2.0 to 2.5 units higher than those in which the oxide was labeled. It is believed that this increase represents the G value for the molecular types of isotopic exchange. The results obtained from the irradiation of mixtures of $^{14}N_2O$ and $^{15}N_2O$ were utilized in developing a new method for determining the thermal neutron component of a mixed radiation field. These same experiments showed that nitrous oxide is reformed during its decomposition and confirmed that $N_2O \longrightarrow N_2 + O$ is the primary step of the radioinduced decomposition. Mixtures of each of the rare gases with nitrogen were also irradiated. The mechanisms of isotopic exchange in these mixtures is undoubtedly very complicated and may even be specific for each mixture. For the helium–nitrogen mixture it was found that the isotopic exchange was greater than in pure nitrogen. (P.C.H.)

4543 (SGAE-CH-37/1966) PERFLUOROALKANES AS FAST-NEUTRON INSENSITIVE CHEMICAL DOSIMETERS. Proksch, E.; Slais, E. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1966]. 16p. (CONF-661005-24). Dep. mn.

From Symposium on Solid-State and Chemical Radiation Dosimetry, Vienna, Austria.

Perfluoroalkanes are especially suitable for use as gamma dosimeters in mixed radiation fields. Their sensitivity to fast and thermal neutrons is small and the yield of the gaseous products formed should be a convenient measure of absorbed dose. Using a gas-chromatographic technique, the amount of fluorocarbon necessary for a single measurement can be reduced to about 100 milligrams. As examples, the "perfluorokerosene" mixtures as well as pure perfluoro-n-hexane were investigated. Both of them proved to be suitable, especially the perfluoro-n-hexane. Without degassing, it may be used with gas yields constant to ±3% in the dose range from 3 to 40 MRAD. A variation in dose-rate from about 50 kRAD/hr to 100 MRAD/hr had but a slight influence on the yields. For measurement of lower doses complete degassing and further purification of the material used was necessary. (auth)

4544 NEW INVESTIGATIONS IN THE REGION OF HETEROGENEOUS RADIATION CATALYSIS AND RADIOACTIVE CATALYSTS. Spizyn, V. I. (Institut fuer Physikalische Chemie, Moscow). Z. Phys. Chem. (Leipzig), 232: 325-42(1966). (In German).

A review is given on the most recent studies on heterogeneous radiation catalysis and radioactive catalysts. The results of the studies were analyzed to determine the relation between mechanism of the radiation effect and the change in catalytic activity. The results suggest that the displacement of the electron density, the origin of ions of abnormal density, and the origin of ion radicals in the irradiated catalysts play essential roles. (J.S.R.)

4545 REDUCTION OF CERIC SULFATE IN PRESENCE OF THALLOUS IONS IN SOLUTIONS IRRADIATED BY ALPHA RADIATION AT 5.3 MeV. Mariano, Helena; Novais, Horacio M. (Laboratorio de Fisica e Engenharia Nucleaires, Sacavem, Portugal). J. Chim. Phys., 63: 1007-10(July-Aug. 1966). (In French).

In the α radiolysis of the Ce^{4+}/Tl^{+} system, the ceric reduction yield values fit the expression $G(Ce^{3+})_{Tl^+} = 2G(H_2O_2)_{Tl^+} + 2G(Tl^{3+})$ where $G(H_2O_2)_{Tl^+}$ is the H_2O_2 formation yield in sulfuric solutions of Tl_2SO_4 void of added solutes and $G(Tl^{3+})$ is the Tl^+ oxidation yield in the Ce^{4+}/Tl^{+} system. The curve $G(Ce^{3+})_{Tl^+}$ vs log (Tl^+) presents a maximum, $G(Ce^{3+})_{Tl^+} = 3.40$ for $(Tl^+) = 2.10^{-4}\underline{M}$. The low value of this maximum, as compared with the theoretical one, is interpreted on the basis of an interference of the Tl^+ ions with reverse reactions of OH radicals within the α-ray track and partial reduction of the Tl^{2+} ions formed, before diffusing to the bulk of the solution. (auth)

4546 PHOTOLYSIS OF PURE WATER VAPOR IN THE PRESENCE OF DEUTERIUM AT WAVE LENGTHS OF 1236 AND 1470 A. Cottin, Maurice; Masanet, Jeannine; Vermeil, Catherine (Institut du Radium, Paris. Laboratoire de Chimie Physique, Paris). J. Chim. Phys., 63: 959-68(July-Aug. 1966). (In French).

Water vapor photolyzed by 1236 Å photons decomposed via two primary processes: $H_2O + h\nu \rightarrow H + OH$ and, $H_2O + h\nu \rightarrow H_2 + O$. The relative probability of these processes depends on the partial pressure of water. The observed hydrogen quantum yield was greater than 1 ($\Phi_{H_2} \simeq 1,5$). When the water was photolyzed in presence of deuterium, a water pressure effect was observed (between 4,5 and 15,5 mm Hg) to play a part in the competitive reactions of H atom scavenging. Both facts can be explained by the formation, in the first primary process of H atoms with kinetic energies high enough to promote the following secondary reaction: $H + H_2O \rightarrow H_2 + OH$. The second primary process was not observed at 1470 Å and the quantum yield for H_2O decomposition was close to 1. No effect of water pressure was observed on H atom scavenging. The extinction coefficient of water vapor at 1470 Å was between 4 and 5 cm^{-1} (N.T.P.). H atom recombination at the walls of the irradiation cell was important at both wavelengths. (auth)

4547 RADIOLYTIC REDUCTION OF PEROXYDISULFATE IONS IN ACID AND NEUTRAL SOLUTIONS. Buu, Antoinette; Pucheault, Jacques (Institut du Radium, Paris). J. Chim. Phys., 63: 1037-43(July-Aug. 1966). (In French).

Sodium peroxydisulfate sulfuric acid solutions were reduced by γ rays with G = 2.7 eq/100 eV. Although no exchange of radioactive sulfur should be observed between HSO_4^- and $S_2O_8^{2-}$ ions, this result led to the assumption of oxidation of sulfuric acid by OH radical, involved elsewhere in radiation chemistry. In neutral solution the yield of reduction is about G = 7.8 eq/100 eV. The systematic examination of the pH and sulfate ion concentration effect shows that OH radicals oxidize HSO_4^-, and not SO_4^{2-} ions. At last, the study of the influence of other different factors (presence or not of air, hydrogen peroxide, hydrogen, etc...) permitted the establishment of radioreduction mechanisms of acid and neutral peroxydisulfate solutions, which are quantitatively in good agreement with radical and molecular yields, known for these pH. (auth)

4548 RADIOCHEMICAL POLYMERIZATION AND COPOLYMERIZATION OF METHYL METHACRYLATE IN VITREOUS STATE. Chapiro, Adolphe; Nakashio, Seizo (CNRS, Bellevue, France). J. Chim. Phys., 63: 1031-6(July-Aug. 1966). (In French).

The radioinduced polymerization of methyl methacrylate in dilute solutions in mineral oil was investigated at temperatures ranging from −63 to −196°C. A study of the structure of these mixtures showed that the monomer was dispersed in small droplets in the vitreous oil phase. The polymerization proceeds in these droplets which remain in a supercooled state down to −130° and form a glass below this temperature. The copolymerization with styrene was also examined under such conditions. An interpretation of all these results is given which emphasizes the phase separation occurring in organic glasses at low temperatures. (auth)

4549 REACTIONS OF HOT ^{14}C ATOMS IN GASEOUS PHASE IN C_2H_4–N_2 SYSTEM. Shvedchikov, A. P. Radiokhimiya, 8: 491-2(1966). (In Russian).

During irradiation of the ethylene–nitrogen system in the gaseous phase with thermal neutrons the ^{14}C hot atoms were found to be stabilized in the form of labeled polymer products. By adding small amounts of C_2H_2 (1 to 10%) the comparative yield of the polymer products in the ethylene–nitrogen system was approximately 20 to 30 times lower than in the ethylene–ammonia system. (auth)

4550 REACTIONS OF ^{14}C RECOIL ATOMS IN ETHYLENE–AMMONIA MIXTURES ADSORBED ON ZEOLITES. Shvedchikov, A. P. Radiokhimiya, 8: 489-91(1966). (In Russian).

Studies showed that during the irradiation of ethylene–ammonia mixtures adsorbed on Zeolite 4A, 5A, and 13X the yields of products in the gaseous phase depends on the type of zeolite. The utilization of irradiation on zeolites as one of the variants in methods using atomic recoil is proposed. (tr-auth)

4551 ALPHA-RADIOLYSIS OF SODIUM NITRATE AND SODIUM NITRITE SOLUTIONS. Ershova, Z. V.; Vladimirova, M. V.; Savelev, Yu. I. Radiokhimiya, 8: 426-31(1966). (In Russian).

The yields of nitrite ions and hydrogen peroxide during the α radiolysis of 0.001 to 6.0 $\underline{M}$ solutions of sodium nitrate in 0.8 $\underline{N}$ H_2SO_4 were determined. By changing the concentration of sodium nitrate from 0.001 to 0.4 $\underline{M}$, the hydrogen peroxide yield was reduced from 1.18 mole/100 eV to 0. By changing the sodium nitrate concentration from 0.3 to 6.0 $\underline{M}$ the nitrite ion yield increased from 0 to 2.35 ions/100 eV. The nitrite ion yields were calculated on the basis of the direct effect of α radiation on sodium nitrate solutions. By changing the sodium nitrate concentration from 0.5 to 6.0 $\underline{M}$ the yield of the direct effect increased from 0.56 to 2.20 ions/100 eV. In the investigation of 1×10^{-4} $\underline{M}$ solutions of sodium nitrite in 0.8 $\underline{N}$ H_2SO_4, the initial yield of the decomposition of nitrite ions was determined from their interaction with water radiolysis products as equal to 2.31 ions/100 eV. (tr-auth)

4552 THERMAL DECOMPOSITION OF IRRADIATED LEAD NITRATE. Mohanty, S. R.; Ray, M. N. (Banaras Hindu Univ., Varanasi, India). Inorg. Nucl. Chem. Lett., 2: 387-90(Dec. 1966).

The role of crystal defects, generated by irradiation, in the thermal decomposition of lead nitrate was investigated. The effect of annealing the irradiated substance on its subsequent thermal decomposition behavior was studied. Ground lead nitrate was irradiated with ^{60}Co γ rays to various doses up to 400 MRAD at a dose rate of 1.5 MRAD/hr. The damaged nitrate was estimated spectrophotometrically. The effect of irradiation was to enhance the decomposition rate and the effect increased with irradiation dose. The influence of temperature on the kinetics of thermal decomposition of lead nitrate, unirradiated and irradiated to a dose of 400 MRAD, was studied. The activation energies were not appreciably affected by irradiation. Annealing of irradiated (400 MRAD) lead nitrate crystals at 160°C restored the decomposition characteristic of the original unirradiated substance. (D.H.M.)

4553 RECOIL SYNTHESIS OF ^{56}Mn-LABELED METHYLMANGANESE PENTACARBONYL. Srinivasan, S. C.; Wiles, D. R.; Yang, I. C. (Carleton Univ., Ottawa). Inorg. Nucl. Chem. Lett., 2: 399-401(Dec. 1966).

Radioactive methylmanganese pentacarbonyl was formed from recoil reaction in neutron–irradiated methylcyclopentadienylmanganese tricarbonyl. The identity of the radioactive compound was established by measuring the radioactivity of macro quantities of carrier $CH_3Mn(CO)_5$ separated from the irradiated target compound. The inactive carrier was added, under nitrogen, after irradiation. The possible mechanism involved in the recoil reaction is discussed. (D.H.M.)

4554 γ DOSIMETRY AT 150 TO 250°C WITH DEAERATED FERROUS SULFATE SOLUTION. Kubota, H. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 28: 3058-6(Dec. 1966). (ORNL-P-2184).

Measurement of the radiation dose absorbed by salt at varying distances from the hot source in storage of solidified wastes in natural salt formations is considered. The dosimeter will be exposed to temperatures up to 250°C for periods up to several hours. Ferrous sulfate and ceric sulfate solutions in sealed containers were investigated as dosimeters. It was assumed that radiation from a ^{60}Co source would approximate very closely the radiation that would be encountered at the test site. Ceric sulfate solutions were not stable at the temperatures involved, but deaerated ferrous sulfate solutions were stable and any changes in optical absorption were due to radiation effects. (M.C.G.)

4555 THE REACTION OF ACETYLENE WITH GAMMA RADIATION UNDER PRESSURE. II. Yashiro, Dairokuro; Naito, Teruyuki (Government Chemical Industrial Research Inst., Tokyo). Radioisotopes (Tokyo), 15: 330-4(1966). (In Japanese).

Acetylene was polymerized by gamma irradiation from ^{60}Co under pressure in the range from 3.5 to 16 atm(absolute) and in the temperature range from 30 to 100°C. The value of $G(-C_2H_2)$ for the over-all reaction was nearly constant in this range, (≈ 80) while $G(C_6H_6)$ decreased from 15 to 6 with increasing acetylene pressure, and $G(-C_2H_2)$ for polymer formation increased from 25 to 60 with increasing pressure. The apparent activation energies for both reactions were very small, and the rates were proportioned to the 0.8th order of dose rate. $G(C_6H_6)$ was not influenced by variation of surface-volume ratio of reaction vessel. G(diacetylene) was less than 1 and approximately proportional to $G(C_6H_6)$ in the range studied. (auth)

4556 INVESTIGATION OF THERMAL CONDUCTIVITY OF LIQUID HYDROCARBONS IN A γ-RADIATION FIELD. Starodubtsev, S. V.; Akbaev, R. A.; Mazitov, B. S. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Dokl. Akad. Nauk Uz. SSR, No. 4, 21-3(1966). (In Russian).

The dependence of thermal conductivity on the temperature and the γ irradiation dose was investigated on the following liquids: toluene, all isomers of xylene, n-hexane, paraffin, and carbon tetrachloride. It was found that in a γ irradiation field the thermal conductivity of the liquid hydrocarbons increases. The γ-induced thermal conductivity changes are directly proportional to the dose and do not depend on the temperature. The temperature dependence of the thermal conductivity λ of toluene was graphed. The value $\Delta = \lambda - \lambda_0$ (λ = thermal conductivity of the liquid in the γ radiation field and λ_0 the thermal conductivity outside the γ field) was measured at a field strength of 250 R/sec and T = 40°C. (J.S.R.)

4557 STUDIES OF VARIOUS ADDITIVES ACTING AS THERMO STABILIZERS IN IRRADIATED POLYETHYLENE. Finkel, E. E.; Vasileva, N. V.; Markman, E. V.; Malashkina, R. T.; Mesenzhnik, Ya. Z. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Dokl. Akad. Nauk Uz. SSR, No. 4, 24-6(1966). (In Russian).

The effects of the additives zinc stearate, zinc oxide, tin oxide, powdered silica gel, and boron oxide as antioxidants in irradiated polyethylene were investigated. The foil samples were exposed to ^{60}Co γ irradiation in the temperature interval 20 to 40°C in oxygen and in vacuo. The stability to fracture and the specific elongation were determined for all samples before irradiation, after irradiation, and after 4-hour annealing in air at 150°C. The results showed that the introduction of the majority of the compounds studied does not impair the characteristics of the original materials, with the exception of powdered silica gel. Its introduction significantly reduces the specific elongation. Irradiation of the polyethylene with the additives in air leads to some increase of the stability of the samples to fracture and sharp reduction of the magnitude of the specific elongation. In the case of irradiation in vacuo the irradiation leads to a very slight change in the stability to fracture and the specific elongation amounted to 100 to 200%. (J.S.R.)

4558 RELATIVE REACTIVITIES OF ALLYLIC COMPOUNDS IN THE γ-RAY INDUCED TELOMERIZATION REACTION WITH CARBON TETRACHLORIDE. Okubo, Masao (Government Industrial Research Inst., Nagoya, Japan). Nippon Kagaku Zasshi, 87: 1191-5(Nov. 1966). (In Japanese).

Nine allylic compounds were dissolved in carbon tetrachloride at molar ratios of 1/5, and γ irradiated at a dose rate of 5.8×10^4 R/hr at 25°C. The main reaction was telomerization with the G-values of 190 for the consumption of allyl acetate, 53 for the production of 2 : 1 telomer of allyl acetate, and 33 for the production of 1 : 1 telomer of allyl benzene. No telomers of higher molecular weights than 3 : 1 telomer were obtained. Reactivities, affected by structures of substituents, were compared with the velocities of consumption of allylic double bonds, as well as with the production ratios of telomers. Higher velocities of double bond consumption were observed on compounds with electron-attracting substituents, but the order of velocities showed no strict agreement with the order of degrees of electron-attracting character of substituents. The bulkiness of substituents showed no relation to the velocity, but allylic compounds with the bulkier substituents were observed to produce more telomers of lower molecular weights. For carboxylic acid esters of allyl alcohol, the order of the velocities of double bond consumption was: allyl benzoate > allyl acetate > allyl formate. This order agreed with the order of the stabilities of produced telomers. (auth)

4559 RELATIVE REACTIVITIES OF ALLYL CARBOXYLATES IN THE γ-RAY INDUCED TELOMERIZATION REACTION WITH CARBON TETRACHLORIDE. Okubo, Masao (Government Industrial Research Inst., Nagoya, Japan). Nippon Kagaku Zasshi, 87: 1196-1200(Nov. 1966). (In Japanese).

Relative velocities of double bond consumption in the γ-radioinduced telomerization reaction with carbon tetrachloride were compared, using allyl esters of sixteen carboxylic acids. In regard to the relation between reactivities of allyl esters and structures of carboxylic acids, the following results were obtained: relative velocities had no reasonable relation with bulkinesses of carboxyl residues; through skeletons of ester molecules, electron-repelling and -attracting effects of carboxyl residues on π-electrons of allyl groups were slight; electronic substituent effects, not found in p-substituted benzoates as stated above, were found in p-substituted phenylacetates; and, reaction of allyl esters of carboxylic acids with no hydrogen atom at α-positions proceeded relatively smoothly. It was concluded that there existed an interaction between α-hydrogen atom of carboxyl residues with π-electrons of allyl groups, and this $C-H\ldots\pi$ interaction could retard the addition of trichloromethyl radical to allylic double bonds. The effect of α-hydrogen atom was found further in the experiment with different dose rates for allyl benzoate and allyl phenylacetate. (auth)

4560 THERMAL ANNEALING PHENOMENA OF LOW TEMPERATURE REACTOR-IRRADIATED CRYSTALLINE In-EDTA. Demetroulas, C. P.; Dimotakis, P. N. (Nuclear Research Center, Athens). J. Inorg. Nucl. Chem., 28: 2756-8(Nov. 1966).

A study of the thermal annealing behavior of reactor-irradiated indium complex with EDTA in the sodium form at liquid nitrogen temperature was made. Isothermal annealing curves are given at the annealing temperatures of 3, 63, and 118°C. Comparison is made of samples irradiated at ordinary temperature (20°C) and at liquid nitrogen temperature (−196°C). (D.H.M.)

4561 RADIATION ANNEALING BEHAVIOR OF THE RADIO-IODINE RECOILS FORMED BY HIGH-ENERGY PROTON IRRADIATION OF CESIUM CHLORIDE. Dema, I.; Zaitseva, N. G. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Inorg. Nucl. Chem., 28: 2491-9(Nov. 1966).

The radioiodine atoms formed by the high-energy proton irradiation of cesium chloride crystals appeared in valency forms affected by the induced lattice defects. The assumption that V-type centers act as strong oxidants for the recoil atoms is discussed. A protection effect of carriers and crushing the crystals, were found to be important in determining the chemical fate of the radioiodine. The yield of radioiodine atoms in higher oxidation states plotted against the total proton flux may be expressed by an equation that shows the proportionality between the number of displaced atoms in the lattice and the total flux of irradiation. (auth)

4562 CHEMICAL STATES OF ^{32}P AND ^{35}S IN NEUTRON-IRRADIATED POTASSIUM CHLORIDE. Cifka, J.; Bracokova, V. (Nuclear Research Inst., Czechoslovak Academy of Science, Rez). J. Inorg. Nucl. Chem., 28: 2483-90(Nov. 1966).

The influence of the conditions of irradiation on the distribution of ^{32}P and ^{35}S atoms among their different valency states was studied. Prolongation of the irradiation decreased the ^{32}P and ^{35}S activity in the hypophosphite and sulfide fractions, respectively. The reduction and subsequent oxidation processes of both products during post-irradiation thermal annealing are enhanced by increasing the duration of the neutron irradiation. Some differences in the behavior of ^{32}P and ^{35}S in lightly irradiated samples were observed. The influence of light on the distribution of both products was investigated. (auth)

4563 ETHYLENE AS A DOSIMETER AT HIGH PRESSURES, TEMPERATURES, AND DOSE RATES. Srinivasan, S.; Smith, W. E. (Socony Mobil Oil Co., Inc., Princeton, N. J.). Int. J. Appl. Radiat. Isotopes, 17: 643-7(Dec. 1966).

Primary hydrogen production from the radiolysis of ethylene was used successfully as a dosimeter in the beam tube of a 5 MW nuclear reactor. C.P. grade ethylene, with an initial hydrogen content of 0.07%, is as satisfactory as research grade ethylene. G-value for hydrogen production (G_{H_2}) is 1.2 ± 0.1, independent of pressures up to 200 psig and temperatures up to 120°C. (auth)

4564 RADIATION-INDUCED OXIDATION OF CYTOSINE AND URACIL IN AQUEOUS SOLUTION OF COPPER (II). Holian,

John; Garrison, Warren M. (Univ. of California, Berkeley). Nature, 212: 394-5(Oct. 22, 1966). (UCRL-16772).

Copper(II) was used as a scavenger of intermediate radicals in the gamma radiolysis of pyrimidine bases. The specific chemical effects of copper(II) in the system involved the preferential oxidation of hydroxypyrimidyl radicals to give the corresponding glycols as the principal products of the radiolysis of both uracil and cytosine. The formation of isobarbituric acid derivatives (5-hydroxypyrimidines) in each case can be attributed to a parallel branching reaction. (D.H.M.)

4565 APPLICATION OF RADIOACTIVE CATALYSTS TO DEHYDRATION OF SPIRITS. **Spitsyn, Vict. I.; Mihailenko, I. E. At. Energ. (USSR), 21: 277-81(Oct. 1966). (In Russian).**

Radiation effects on catalytic processes were analyzed. It is shown that radioactive admixtures to the catalyst considerably altered the rate and energy of the apparent alcohol dehydration and in some cases the direction of the heterogenous-catalytic reactions. Radiation changed the quality of the catalyst and strongly influenced the adsorbed layer of molecules on the catalyst surface by inducing their polarization. The polarization magnitude depended on the structure of reacting molecules. (tr-auth)

4566 STRUCTURE AND REACTIVITY OF TRANSITION-METAL COMPLEXES WITH POLYATOMIC LIGANDS. PART IV. ELECTRON SPIN RESONANCE SPECTRA OF γ-IRRADIATED SODIUM NITROPRUSSIDE. Goodman, B. A.; McNeil, D. A. C.; Raynor, J. B.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc. (A), No. 11, 1547-51(1966).

Electron spin resonance spectra were recorded for γ-irradiated hydrated and anhydrous sodium nitroprusside. The paramagnetic species in the anhydrous salt, and in polarographically reduced sodium nitroprusside in dimethylformamide was identified as the ion $[Fe(CN)_5NO]^{3-}$ having linear Fe—N—O bonds, whereas the species in the hydrated salt is possibly $[Fe(CN)_4(CNOH)(NO)]^{2-}$ having an Fe—N—O bond angle of about 170°. The directions and the magnitudes of the g and ^{14}N hyperfine tensors were in accord with an electron configuration e^4, b_2^2, a_1^1, the a_1 orbital being primarily d_{z^2}. Some radicals were trapped in pairs giving a weakly interacting triplet state. Single-crystal measurements of the spectra from such pairs showed that the unpaired electron was localized mainly on the iron nucleus. None of these results is compatible with the configuration $1e^4$, b_2^2, $2e^1$ in which the 2e orbital is largely π^* (NO). (auth)

4567 ROLE OF EXCITED STATES IN THE FORMATION OF H_3O^+ BY ELECTRON BOMBARDMENT OF WATER VAPOR. Peers, Arthur Mackenzie; Cottin, Maurice (Laboratoire Curie, Paris). **J. Chim. Phys., 63: 1346-50(Oct. 1966). (In French).**

The ratio of positive ion currents, H_3O^+/H_2O^+ obtained by electron bombardment of water vapor was measured for nominal incident electron energies of 11.0 to 20.0 eV. Within experimental error, all H_3O^+ observed was produced by second order reactions. A fraction of the H_3O^+, however, was produced at a rate which was independent of the field strength in the ion source. The reaction $H_2O^* + H_2O \rightarrow H_3O^+ + (OH + e)$, involving an excited molecule, is proposed to account for this result. The variation of the ratio H_3O^+/H_2O^+ with incident electron energy suggests that the cross section for the ion-molecule reaction $H_2O^+ + H_2O \rightarrow H_3O^+ + OH$ is smaller when the primary ion is in an excited electronic state, in qualitative agreement with the phase-space theory of light. Evidence of excited-state participation in the ion-molecule reaction has been obtained for incident electron energies of about 14.5 and 16.3 eV. (auth)

4568 STUDY OF THE THERMAL DECOMPOSITION OF IRRADIATED GIBBSITE. **Boury, Michel; Dalmai, Gisele; Imelik, Boris (CNRS, Villeurbanne, France). J. Chim. Phys., 63: 1406-8(Oct. 1966). (In French).**

Irradiation of gibbsite by gamma rays or by neutrons considerably modified its thermal decomposition. For temperatures lower than 210°C and in comparison to a standard solid, the decomposition was delayed and the activation energy of the reaction was greater than for the non-irradiated sample. On the other hand for higher temperatures the decomposition was faster and the activation energy lower. The decomposition of the boehmite formed during the decomposition of gibbsite was also faster in the case of irradiated samples. It seems probable that irradiation by gamma rays or neutrons destroys the substance normally responsible for the decomposition of gibbsite introducing at the same time other substances, which under certain conditions, may increase the rate of the dehydration reaction. (auth)

4569 EFFECT OF ORGANIC HALIDES OF THE YIELD OF HYDROGEN FROM γ RADIOLYSIS OF METHANOL. Matsuoka, Haruko; Sato, Kuniyoshi; Masuda, Takahiro; Kondo, Masaharu (Tokyo Metropolitan Univ.). Nippon Kagaku Zasshi, 87: 1320-2 (Dec. 1966). (In Japanese).

Kinetic studies on the effects of CCl_4, C_6H_5Cl, and $p-C_6H_4Cl_2$ on radiolytic yield of hydrogen from methanol showed that the G-value for solvated electrons as a precursor of hydrogen was 2.0. The yield of hydrogen from methanol in the presence of sulfuric acid and that of chloride ion in the presence of halides gave evidence of solvated electrons which can be scavenged by solutes but form no hydrogen and the G-value of which is determined as approximately 0.6. (auth)

4570 RADIATION-INDUCED DEGRADATION OF POLY (METHYL METHACRYLATE) IN MIXED SOLVENTS. **Polowinska, A.; Turska, E.; Kroh, J. (Technical Univ., Lodz, Poland. Lab. of Physical Chemistry of High Polymers, Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 555-8(1966).**

Studies were made on the effects of polymer concentration on gamma radioinduced decomposition of poly(methyl methacrylate) (PMMA) in acetone—benzene and on the decomposition occurring on irradiation of the system PPM—acetone—ethyl acetate. For solutions in acetone—benzene, it was concluded that there was practically no correlation between the shape of the PMMA macromolecule and the yield of decomposition. In contrast to the benzene—acetone system, no maximum shielding effect was observed for the acetone—ethyl acetate system. No influence of specific viscosity on the radioinduced decomposition of PMMA in solution was observed. (P.C.H.)

4571 RADIOLYSIS OF THE ETHANOL-BENZENE SYSTEM IN THE PRESENCE OF IODINE. Kroh, J.; Bogus, W.; Mayer, J. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 14: 559-63(1966).

The radiolysis of ethanol—benzene system in the presence of iodine was investigated by examining the radiation yield of methane as a function of the electron fraction of benzene in ethanol at a constant iodine concentration. The values of $G(CH_4)$ plotted against the electron fraction of benzene in mixture with ethanol and ethanol—iodine were found to have a similar shape. Also, results for both systems in terms of the $\Delta G/G_0$ against benzene concentration led to the same curve. This is explained by transfer of energy from excited ethanol molecules to benzene. Kinetics of the reactions involved are discussed. (P.C.H.)

4572 Zn, CdS(Cu) LUMINESCENCE EXCITED BY ^{147}Pm β RADIATION. Del Monaco, A.; Parolini, G.; Serra, M. (Univ., Rome). Energ. Nucl. (Milan), 13: 687-90(Dec. 1966).

Luminous sources formed by a ZnCdS(Cu) and $^{117}PmCl_3$ mixture were studied in view of their possible utilization. Radiances, luminous fluxes, and specific efficiencies were measured as a function of an activity of ^{117}Pm varying from 0.1 to 2 curie. The maximum values of radiance and specific efficiency were found to be 35 lux s.b. and 52 lumen/watt respectively. (auth)

4573 PREPARATION OF PURE WATER AS A SOLVENT IN RADIATION CHEMISTRY. Sarrach, D. (Institut fuer Anwendung Radioaktiver Isotope, Berlin). Isotopenpraxis, 2: 338-9(Aug. 1966). (In German).

A water purification installation for the preparation of water to be used in radiation chemistry is described and illustrated in detail. (J.S.R.)

4574 PRODUCTS FROM THE RADIOLYSIS OF LIQUID AMMONIA. **Belloni, Jacqueline (Laboratoire Curie, Paris). J. Chim. Phys., 63: 1281-2(Sept. 1966). (In French).**

Liquid ammonia in previously irradiated glass ampoules was irradiated with ^{60}Co γ rays ($I = 1.3 \times 10^{19}$ eV/ml hr) at 18°C. At the end of the irradiation, the ampoules were frozen at −196°C and their contents were analyzed. The formation of NH_4N_3, both from the long-time irradiation of ammonia and from the decomposition of the hydrazine formed, was indicated. A mechanism for its formation is proposed. (J.S.R.)

4575 THERMOLUMINESCENCE CHARACTERISTICS OF FLUORITE MINERALS OF DIFFERENT QUARRIES. **Kaufhold, J.; Herr, W. (Univ., Cologne). Radiochim. Acta, 6: 100-6(Oct. 1966). (In German).**

In fluorite minerals from different quarries changes in glow curves and emission spectra that appeared after heat treatment and renewed irradiation were compared to the "natural" thermoluminescence. Two different fluorite groups were found. In the first group distribution of trapping and recombination centers was retained; this was not the case with the second group. After the first treatment the original main glow maximum did not appear any longer and simultaneously the characteristic spectral band disappeared. In both samples, moreover, there was a large decrease in the concentration of centers after heating for one hour up to 900°C. These changes in quality are of particular interest for thermoluminescence dosimetry with "natural" crystals of

CaF_2 and for experiments to determine the radiation age of fluorites and meteorites. (auth)

4576 RADIOLYSIS OF LIQUID NITROMETHANE. Corey, James Laurence. Columbus, Ohio, Ohio State Univ., 1965. 131p. Thesis.

Products of the radiolysis of purified air-free liquid nitromethane were identified by gas chromatography and ultraviolet and infrared spectroscopy. These products are N_2, H_2, CO, CH_4, NO, N_2O, CH_3ONO, CH_2O, CO_2, C_2H_6, CH_3ONO_2, $(CH_3NO)_2$, $(CH_2NOH)_3$, and H_2O. There is also evidence of the presence of nitrous acid. Gas chromatography was also used to determine quantitatively the concentrations of the gaseous and liquid products. The nonvolatile cis nitrosomethane dimer was determined spectrophotometrically. Water and formaldoxime trimer were not quantitatively determined. It was found that at 25°C a post-irradiation "dark reaction" occurs, which produces CH_4, CH_3ONO, CH_3ONO_2, CO_2, N_2O, and N_2. The nitrosomethane dimer, $(CH_3NO)_2$, is consumed. At 25°C the results show that CH_2O, CH_3ONO, and $(CH_3NO)_2$ are the major products with initial G-values of 2.0, 1.1, and 0.53, respectively. With the exception of CH_2O, H_2, CO, and C_2H_6, the mole fractions and hence the G-values of the other products show a nonlinear dose dependence. Evidence is presented in favor of a secondary reaction between CH_3NO and NO, which is responsible at least in part for the nonlinear behavior of some of the products. Possible reaction mechanisms are discussed. On the basis of product yields, dose and temperature dependence, and comparisons with the work of others, it seems likely that the following reactions occur, although these are not necessarily the only primary reactions: $CH_3NO_2^* \rightarrow CH_3 + NO_2$ or $CH_3NO_2^+ \rightarrow CH_3 + NO_2^+$ and $e + CH_2NO_2 \rightarrow CH_3NO_2^- \rightarrow CH_3NO + O^-$ where * indicates an excited molecule. (Dissertation Abstr.)

4577 METHOD FOR RADIATION-COPOLYMERIZATION OF FORMALDEHYDE AND ISOCYANIC ACID. Hamada, Michio (to Ube Industries Ltd.). Japanese Patent 1965-23800. Oct. 19, 1965. Filed Jan. 22, 1963.

In the proposed method for the copolymerization of formaldehyde and isocyanic acid, a copolymer with a high degree of polymerization was produced by irradiating a mixture of formaldehyde and isocyanic acid in the solid or liquid state at a temperature between −200 and 0°C. (NSA of Japan)

4578 METHOD FOR RADIATION-POLYMERIZATION OF ISOCYANIC ACID. Hamada, Michio (to Ube Industries Ltd.). Japanese Patent 1965-22595. Oct. 6, 1965. Filed Jan. 22, 1963.

In the method proposed for radioinduced polymerization of isocyanic acid, a linear polymer of isocyanic acid with a high degree of polymerization is produced by irradiating the monomer with ionizing radiation in the temperature range from −200 to 50°C; the monomer may be either in the solid or in the liquid state by dissolving it with an appropriate solvent. (NSA of Japan)

4579 METHOD FOR PRODUCING HEAT-STABLE POLYOXYMETHYLENE. Nomura, Sueichi (to Toyo Koatsu Industries, Inc.). Japanese Patent 1965-21356. Sept. 22, 1965. Filed Dec. 29, 1962.

A method is proposed for producing thermally stable polyoxymethylene by radioinduced copolymerization of tetraoxymethylene with isocyanate. Tetraoxymethylene or the tetramer of formaldehyde are irradiated in the presence of isocyanate compounds in the solid state with ionizing radiation. (NSA of Japan)

4580 METHOD FOR RADIATION-COPOLYMERIZATION OF ISOCYANIC ACID AND KETENE. Hamada, Michio (to Ube Industries Ltd.). Japanese Patent 1965-23799. Oct. 19, 1965. Filed Jan. 22, 1963.

In the method proposed for copolymerization of isocyanic acid and ketene, the copolymer with a high degree of polymerization is produced by irradiating a mixture of isocyanic acid and ketene, diluted with an appropriate solvent, in the solid or liquid state in the temperature range from −200 to 0°C with ionizing radiation. (NSA of Japan)

4581 METHOD FOR PRODUCING A POLYVINYL CHLORIDE COMPOSITION. Suzuki, Fumio (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1965-29019. Dec. 23, 1965. Filed Mar. 11, 1963.

A method is proposed for producing a composition having polyvinyl chloride component; an epoxy compound is added to polyvinyl chloride and then the mixture is crosslinked by ionizing radiation. Conventional irradiation methods for producing crosslinked polyvinyl chloride are as follows: use of an accelerating agent such as unsaturated (polyfunctional) compounds and sulfur compounds, irradiation of the polymer in water, immersion of the polymer in the solvent after irradiation, irradiation of the polymer in a special atmosphere (ammonia, nitrogen, or in vacuum), irradiation of the polymer in solvents, and heating of the polymer after irradiation. In the method proposed, various kinds of additives and a suitable amount of epoxy compound are added to polyvinyl chloride and then the mixture is irradiated; the resulting product is highly improved in its properties. The irradiation can be carried out very satisfactorily in the air. Vinyl chloride polymer gives the best result, but other copolymers may also be utilized similarly. (NSA of Japan)

4582 POLYACRYLONITRILE CONTAINING KETENE-IMINE LINKAGES PRODUCED BY HIGH ENERGY RADIATION. Levine, Charles A.; Diethelm, Conrad A. (to The Dow Chemical Co.). U. S. Patent 3,278,405. Oct. 11, 1966. Filed May 2, 1962.

A method is described for the preparation of acrylonitrile polymers using high-energy radiation, wherein an appreciable amount of monomer addition occurs through the 1,4 positions rather than solely through the usual 1,2 positions. Improved dye reception and retention qualities in polyacrylonitrile films, fibers, filaments, and cognate structures are provided through incorporation of ketene-imine linkages in the polymeric product. (P.C.H.)

Radiochemistry

4583 REACTIONS OF ^{38}Cl RECOIL ATOMS IN THE BINARY SYSTEM CCl_4–BENZENE AND CCl–TOLUENE. I. RECOIL CHLORINATION OF AROMATIC COMPOUNDS. Stoecklin, G.; Tornau, W. (Institut fuer Radiochemie, Juelich, Ger. Univ., Cologne). Radiochim. Acta, 6: 86-93(Oct. 1966). (In German).

The chemical reactions following the $^{37}Cl(n,\gamma)^{38}Cl$ process in the binary CCl_4–benzene and the CCl_4–toluene systems were investigated and the radiochemical yields of the different products were determined by radio-gaschromatography. A characteristic dependence of the $^{38}ClCCl_3$, $C_6H_5{}^{38}Cl$, and $C_7H_7{}^{38}Cl$ yields, respectively, can largely be attributed to a superposition of reactions of different chlorinating species. Accordingly, the recoil chlorination of benzene and toluene takes place via replacement reactions of "hot" ^{38}Cl atoms as well as via highly excited primary recoil products, $(^{38}ClCl)^*$ and $(^{38}ClCCl_3)^*$. The distribution of the ^{38}Cl activity among the monochloro isomers of toluene in the CCl_4–toluene system is dependent on the composition of the system and does not follow the classical rules of substitution. Contrary to the investigated γ radiolysis and the dark chlorination in the same system, the marked preference of the o-position decreases with an increase in the toluene concentration, whereas the substitution of the m-position as well as that of the side chain (benzyl chloride) increases. Almost statistically proceeding replacement reactions predominate. (auth)

4584 NATURE OF (n,γ) AND (I.T.)-ACTIVATED BROMINE REACTIONS IN LIQUID ISOMERS OF HEXANE. Merrigan, Joseph A.; Nicholas, J. Blair; Rack, Edward P. (Univ. of Nebraska, Lincoln). Radiochim. Acta, 6: 94-100(Oct. 1966).

The ^{82}Br organic yields from ^{82m}Br (I.T.) ^{82}Br activations were found to be generally 1.7 to 1.8 times the yields of ^{80m}Br, ^{82m}Br, and ^{82}Br from (n,γ)-induced reactions in all of the liquid isomers of hexane at Br_2 concentrations above 0.05 mF. Scavenger curves and product distributions were found and evaluated with regard to several existing hypotheses of the mechanisms of liquid-state bromine reactions resulting from nuclear activation. A possible correlation was found between organic yields at given Br_2 concentrations and G-values for total organic radicals produced by x rays in the hexanes. This and other considerations support the Auger electron reaction hypothesis for the reactions and systems studied. (auth)

4585 PROCESSES ASSOCIATED WITH THE $^6Li(n,\alpha)^3H$ NUCLEAR REACTION. II. REACTIVITY OF TRITIUM IN DIFFERENT LITHIUM COMPOUNDS. Costea, T.; Mantescu, Constanta (Inst. of Atomic Physics, Bucharest). J. Inorg. Nucl. Chem., 28: 2777-86(Dec. 1966).

The reactivity of recoil tritium produced in LiF, LiCl, LiBr, LiI, Li_2CO_3, Li_2CrO_4, Li_2CrO_4.aq, $LiNO_3$, NiO(Li), $LiAlH_4$, and LiH was studied. By following the thermal release of the volatile tritium species and also by dissolving the samples in water the yields of tritium compounds were established. The conditions under which different tritium compounds appear and the factors determining release of the volatile tritium compounds are discussed. (auth)

4586 PREPARATION OF POINT SOURCES OF β-EMITTERS FOR THE IRRADIATION OF TISSUE CULTURES. Babicky, A.; Liebster, J.; Lodin, Z.; Chromec, Ch.; Linhart, J. (Inst. for Biological Research, Prague Inst. of Physiology, Prague). Int. J. Appl. Radiat. Isotopes, 17: 662-3(Dec. 1966).

Two methods were used for the preparation of point sources of β-emitters for the irradiation of tissue cultures. ^{32}P was prepared by adsorption of the carrier-free radioisotope from a solution of

$Na_2H^{32}PO_4$ by ion-exchanger grains. A ^{90}Sr-^{90}Y solution was used in the preparation of ^{90}Sr. ^{90}Y was precipitated in a capillary. (J.G.B.)

4587 STANDARDIZATION OF A $^{90}Sr + ^{90}Y$ SOLUTION WITH THE AID OF A CHEMICAL SEPARATION. Rytz, A. (Bureau International des Poids et Mesures, Sevres, France). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/48, 16p. (CONF-661012-22). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Precipitation by fuming nitric acid of strontium in a $^{90}Sr + ^{90}Y$ solution offers an opportunity of preparing sources in which, at first, one of the two activities is much weaker than the other. If the initially weaker activity is known, the other can be calculated from the count rates measured at two suitably chosen times. A procedure was developed that quantitatively connects the specific activity of the mother solution with that of the solution dispensed onto the source mounts. The main difficulty was encountered in determining the initial ^{90}Y activity of the ^{90}Sr-enriched sources. If the ^{90}Y is distributed uniformly after the precipitation, the corresponding ^{90}Y activity retained by the precipitate can be calculated easily. Yet the ^{90}Y concentration sometimes deviated significantly from uniformity. A way of partially circumventing this difficulty is pointed out. Exact formulas are derived expressing the activities in terms of the count rates observed at different times. A full account of the various sources of error is given; the spread of the results obtained is compatible with that expected. The specific activity of the mother solution was calculated with 15 sources prepared from four independent precipitations. The mother solution was calibrated by 24 laboratories taking part in an international comparison organized by the BIPM in 1964. The agreement was well within the limits of error. The separation method described may be used as an independent method of standardizing a pure β emitter by β counting alone, without using any extrapolation. The accuracy reached compares favorably with that of more currently used methods. The separation method may be superior to others when a $^{90}Sr + ^{90}Y$ solution with a high carrier content is to be standardized. (auth)

4588 REFERENCE SPECTROMETRIC ALPHA SOURCES. Aleksandrov, B. M.; Belyatskii, A. F.; Berkovich, I. B.; (and others). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/75, 30p. (In Russian). (CONF-661012-7). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

A method was developed for the fabrication of 21 different types of reference alpha sources with both one and a mixture of different isotopes and for determining the basic physical characteristics of spectrometric sources in which the following isotopes are used: ^{233}U, ^{239}Pu, ^{241}Am, ^{238}Pu, ^{244}Cm, ^{242}Cm, and ^{228}Th. These reference sources are designed for calibrating semiconductor alpha spectrometers and other spectrometric and counting apparatus. The alpha particles emitted by the source have a small energy scatter. The sources fall into three categories, depending on the "intrinsic half-width of the alpha lines": up to 10 keV, 10 to 20 keV, and 20 to 50 keV. Most of the sources fall into the first two categories. The energies of the alpha particles emitted by the reference sources were determined to within 2 to 5 keV. With the help of a precision magnetic alpha spectrometer, the shape of the alpha lines was investigated in the process of developing the method of manufacturing the source, and a constant check was kept on the energy shift of the alpha lines due to self-absorption and to energy losses from the film coating. The activities of the reference sources lie within the range $3 \times 10^2 - 3 \times 10^5$ disintegrations per second and are determined to within 2 to 4%. In most of the reference sources the layer of radioactive substance is firmly attached to the base, and in a number of cases covered by a film. The base consists of a metallic disc (diameter 24 or 35 mm, thickness 1 mm). The diameter of the active spot is 12 mm. The fabrication process is also applicable to reference sources including ^{210}Po, ^{226}Ra, and ^{227}Ac sources. (auth)

4589 MEASUREMENT OF THE ACTIVITY OF HIGH-ACTIVITY ^{60}Co SOLID SOURCES BY THE APPLICATION OF NUCLEAR PHOTO EFFECT. Veres, A.; Pavlicsek, I.; Ozsgyani, M. (National Atomic Energy Commission, Budapest). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/5, 8p. (CONF-661012-27). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Experimental results obtained by measuring the activity of ^{60}Co sources with activities between 20 and 3000 Ci by the application of nuclear photo effect are presented. To determine the activity of the irradiating source the isomeric activities of ^{115m}In and ^{111m}Cd were used. The method provides an accuracy of about 5% Due to the simplicity and good feasibility of the measurement the method offers many advantages within the activity range from 10 to 10^4 Ci. Besides ^{60}Co sources two others can be measured in the range mentioned above, provided they have gamma radiation of an energy higher than 1 MeV. By means of this method and by selecting an adequate target for detector, equipment for very rapid measurements can be constructed. (auth)

Separation Processes

Refer also to abstracts 4474, 4476, 4508, and 5608.

4590 (ANL-7125, pp 21-60) COMPACT PYROCHEMICAL PROCESSES. (Argonne National Lab., Ill.).

Development work continued on compact pyrochemical processes for the recovery of U and Pu from fast breeder reactor fuels. The basic separations in present process concepts are accomplished through differences in the partition behavior of the fuel constituents between liquid metal and salt solvents. These processes have applicability to oxide, carbide, and metal reactor cores and blanket material. Laboratory-scale and engineering-scale investigations are described, along with process equipment development for the skull reclamation process and fuel cycle facility operations. (P.C.H.)

4591 (ANL-7125, pp 61-106) FUEL CYCLE APPLICATIONS OF VOLATILITY AND FLUIDIZATION TECHNIQUES. Jonke, A. A.; Barghusen, J. J. (Argonne National Lab., Ill.).

Studies on processing methods for the recovery of U and Pu from spent reactor fuel materials by fluoride volatility techniques are reported. The two-zone oxidation-fluorination method was used for UO_2-PuO_2 pellets containing fission products. In some cases cesium fluoride was added to the alumina beds, and higher retention of U and Pu on the alumina bed was obtained. Studies of the kinetics of the reactions between BrF_5 and several uranium compounds were performed to provide data necessary for defining processing conditions for the interhalogen flowsheet. It was found that none of the Pu is converted to PuF_6 by reaction between BrF_5 and PuO_2 and that the PuF_4 product can be converted readily to PuF_6 by the high-temperature reaction with fluorine. The kinetics of the fluorination of NpF_4 by elemental fluorine were studied at 250 to 400°C. An investigation was initiated to determine the rates of corrosion of nickel-200, Monel, and Inconel coupons by some of the volatile fission product fluorides, such as GeF_4, AsF_5, SeF_6, MoF_6, and TeF_6, either individually or in the presence of fluorine. Studies on the cleanup of cell exhaust air contaminated with PuF_6 were continued. Experimental work related to bench-scale fluid-bed volatility process studies with irradiated Al-U alloy fuel materials was completed and the results are given. (P.C.H.)

4592 (ANL-7125, pp 107-18) STUDIES AND EVALUATIONS. Mecham, W. J.; Trice, V. G. Jr.; Levenson, M. (Argonne National Lab., Ill.).

Studies and evaluations were continued to estimate cost differentials among alternative cases in the processing of reactor fuels in conceptual facilities to be operated in about 1980. Estimates were made of the cost of close-coupled processing of the core and blanket fuel discharged from a hypothetical 1000 MW(e) oxide-fueled fast breeder reactor. Cost estimates were made of three types of close-coupled plants: an aqueous-solvent extraction plant; a fluid-bed fluoride volatility plant; and a compact pyrochemical plant. The plant specifications were based on reference process flowsheets. Conceptual designs for process plant and waste disposal plant based on these flowsheets were used in making detailed estimates of investment costs and processing costs and, ultimately, net unit fuel cycle costs. For the portion of the fuel cycle comprising chemical processing, waste disposal, out-of-reactor fuel inventory, and processing losses, values of the total net unit costs were 0.58, 0.67, and 0.87 mill/kW(e)-hr, respectively, for the volatility, pyrochemical, and aqueous plants. (P.C.H.)

4593 (ORNL-P-2409) ENGINEERING AND MAINTENANCE PROBLEMS IN A FUEL PROCESSING PILOT PLANT USING THE VOLATILITY METHOD. Nicol, R. G. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 33p. (CONF-661001-22). DTIE.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Success of the Molten-Salt Fluoride-Volatility Pilot Plant at Oak Ridge National Laboratory was attributed, in part, to solution of engineering and maintenance problems encountered. Major engineering problems, which differed in some respects from those encountered in aqueous processes, were those associated with fuel element charging, waste salt disposal, pipeline plugging, process control, vessel corrosion, and radiation hazards control. Major maintenance problems consisted of repair and revision of process equipment in a primary containment zone by using direct methods. (auth)

4594 (ORNL-P-2601) CHEMICAL SEPARATIONS IN MOLTEN FLUORIDES. Blankenship, F. F. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 9p. (CONF-660524-25). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 2nd International Thorium Fuel Cycle Symposium, Gatlinburg, Tenn.

The separation of iodine from molten fluoride fuels containing LiF, BeF_2, UF_4, and possibly ZrF_4 and rare earths from Molten Salt Reactor Fuel containing LiF, BeF_2, and ZrF_4 are discussed. Iodine was removed by sparging with HF, and the rare earths were removed by distillation of the fuel constituents. (P.C.H.)

4595 (ORNL-P-2731) A GAS SORPTION-DESORPTION RECOVERY METHOD FOR PLUTONIUM HEXAFLUORIDE. Katz, Sidney; Cathers, G. I. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 17p. (CONF-660907-4). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society Meeting, New York.

A sorption process for recovering PuF_6 that may be applicable to fluoride-volatility processing is described. The reaction between PuF_6 and LiF is shown to be a selective and reversible method of collecting PuF_6, possibly decontaminated from highly radioactive fission products. LiF was chosen as the optimum sorbent because PuF_6 can be completely regenerated from this material more easily than from other fluorides. Two typical flowsheets are suggested. It is also suggested that an oxidation-reduction equilibrium between the solid $(LiF)_4PuF_4$ complex and PuF_6-F_2 gas is the probable mechanism involved. (M.C.G.)

4596 (ORNL-TM-1664) THE DISTRIBUTION COEFFICIENT OF TRIVALENT GOLD IN METHYL ISOBUTYL KETONE/HYDROCHLORIC ACID AND BIS-(β-CHLOROETHYL) ETHER/HYDROCHLORIC ACID SYSTEMS AS A FUNCTION OF THE CONCENTRATION OF HYDROCHLORIC ACID AND THE CONCENTRATION OF GOLD. Pinajian, J. J. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The bis(β-chloroethyl) ether and methyl isobutyl ketone extraction of gold(III) chloride from hydrochloric acid solutions was studied as a function of the gold concentration and the hydrochloric acid concentration. Values of the K_D are given for 0.0125 to 100mM Au(III) chloride and 2 to 10M HCl [bis(β-chloroethyl) ether] and 1 to 6M HCl [methyl isobutyl ketone]. The extraction of gold(III) chloride from hydrochloric acid solutions by methyl isobutyl ketone was found to be from 25 to 250 times more efficient than by the use of bis(β-chloroethyl) ether. (auth)

4597 REPROCESSING OF SPENT NUCLEAR FUELS IN EUROPE: PROBLEMS OF EUROCHEMIC. Rometsch, R. (EUROCHEMIC, Mol, Belg.). Atomwirtschaft, 11: 423-7(Aug.-Sept. 1966). (In German).

The market and objectives for reprocessing of spent fuel elements in Europe are determined by the output of such materials from nuclear reactors, from which a large increase is expected up to 1975. The value of the recoverable fissionable materials during the next five years is estimated to be about fifty million dollars. The reprocessing capacity will amount to more than twice the requirement. Since all plants are government supported, the resulting competition takes effect in the total fuel cost. (tr-auth)

4598 URANIUM(VI) EXTRACTION FROM AQUEOUS PERCHLORATE SOLUTIONS BY DI(2-ETHYLHEXYL) PHOSPHORIC ACID IN n-OCTANE. Ul'yanov, V. S.; Sviridova, R. A.; Laskorin, B. N. Radiokhimiya, 8: 416-20(1966). (In Russian).

The reaction constants at a temperature of 20°C and $\mu = 0.1$ during the extraction of uranium from bis(2-ethylhexyl)phosphate in octane were determined as: $UO_{2B}^{2+} + 2HA_0 \rightleftharpoons UO_2A_{2_0} + 2H_B^+$, $\lg K_6 = 3.85 \pm 0.06$; $UO_{2B}^{2+} + 2H_2A_{2_0} \rightleftharpoons UO_2A_2 \cdot 2HA_0 + 2H_B^+$, $\lg K_7 = 4.27 \pm 0.04$; $UO_{2B}^{2+} + 2A_B^- \rightleftharpoons UO_2A_{2_0}$, $\lg K_{11} = 13.53 \pm 0.08$; $UO_{2B}^{2+} + 2A_B^- + 2HA_B \rightleftharpoons UO_2A_2 \cdot 2HA_0$, $\lg K = 29.77 \pm 0.09$. It was found that in the range of low concentration of bis(2-ethylhexyl)phosphate the reaction with the monomer takes place $UO_{2B}^{2+} + 2HA_0 \rightleftharpoons UO_2A_{2_0} + 2H_B^+$. With an increase in extractant concentration, further addition of the HA molecule or reaction with the dimer begins. (auth)

4599 EXTRACTION ISOTHERMS AND DISTRIBUTION DIAGRAMS IN TETRACOMPONENT SYSTEMS. Nikolaev, A. V.; Ryabinin, A. I.; Afanasev, Yu. A. Radiokhimiya, 8: 421-6(1966). (In Russian).

With the extracting system $Th(NO_3)_4$-HNO_3-H_2O-TBP as an example, it was found that investigation of the mutual extraction of two components must be accomplished by the construction and analysis of distribution diagrams. The distribution diagram method has the following advantages over the common methods of experimental construction of the extraction isotherm: expenditures of work and time in carrying out the experiment are significantly less because the condition for the preservation of a constant concentration of one of the extracting components is absent; the distribution diagram with extraction data gives the possibility of obtaining practically any extraction isotherm which is equivalent with the isoline of the distribution coefficients; and analysis of the data in the light of the extraction makes it possible to obtain supplementary information on the pattern of repeated extractions. (tr-auth)

4600 EFFECTS OF pH ON THE RADIOACTIVE ISOTOPE EXTRACTION FROM SOLUTIONS WITH COLLOIDAL IRON HYDROXIDE BY FOAM FORMATION METHOD. Pushkarev, V. V. Radiokhimiya, 8: 431-6(1966). (In Russian).

For concentrating radioactive strontium, yttrium, and zirconium with niobium, ruthenium, cesium, and cerium from solutions by the foam formation method, conditions were studied for the separation of isotope carrier in the form of iron hydroxide colloids (50 mg/l) with the production of precipitates containing the largest quantity of moisture. It was established that the pH of the solution, gelatin content, air flow-through velocity across the column of liquid, and the difference in the surface level of the liquid and overflow height of the foam fractions show a significant effect on the precipitate moisture. Yttrium (at pH ≥ 6.0), zirconium with niobium (pH ≥ 2.3), and cerium (pH ≥ 6.5) were extracted from solutions with a 96.0 to 99.0% efficiency. The maximum extraction of ruthenium (pH ≃ 5.0) is ~90.0%, and that of strontium (pH ≃ 10.0) was 97.0%. The dependence of the isotope extraction (with exclusion of strontium) with foam formation on the solution pH according to its character is analogous to the sorption from iron hydroxide under static conditions. The addition of small quantities of gelatin does not change the ion-forming nature of the sorption. The effect of foamers appears only in the character of the sorption of strontium. (tr-auth)

4601 ANALYSIS OF THE COMBUSTION OF GRAPHITE-URANIUM FUELS IN A FIXED BED OR MOVING BED. Scott, Charles D. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop., 5: 223-33(July 1966).

A proposed first step in processing graphite-uranium nuclear fuels for the recovery of uranium is burning of the fuel by oxygen and/or air in a fixed or moving bed to remove the carbon and oxidize the uranium. To predict effects of operating variables and point out potential problems, an analysis was made of the reaction system which includes consideration of both reaction kinetics and mechanisms of heat transfer. A mathematical model of the process was derived and numerical solutions were made. Results of the analysis compare favorably with experimental results, and several potential operational problems were revealed, such as high carbon monoxide content and excessive heating. Safe operating conditions were predicted for deep beds of fuel in tubular and annular reactors. (auth)

4602 DISSOLUTION OF GRAPHITE-BASE REACTOR FUELS BY PRESSURIZED AQUEOUS PROCESSES. Haas, Paul A.; Ferris, Leslie M. (Oak Ridge National Lab., Tenn.). Ind. Eng. Chem., Process Design Develop., 5: 234-8(July 1966). (ORNL-P-1544; CONF-650902-9).

The combustion of the graphite matrix and dissolution of the uranium and thorium carbides or oxides in graphite-base nuclear reactor fuels were studied in a single vessel containing nitric acid solutions and oxygen under pressure. Both batch autoclaves and a continuous reactor system were utilized. With excess oxygen present, the net combustion reaction was $C + O_2 \rightarrow CO_2$. With fuel containing Th-U dicarbide particles coated with pyrolytic carbon, complete combustion of the carbon coatings and the graphite, and dissolution of the thorium and uranium, were achieved in 2 to 10 M HNO_3 in 24 hours when the $HNO_3/(Th + U)$ mole ratio was greater than 50. Oxidation of unfueled graphite was studied in a system where gases were continuously added and removed. Rate constants, as grams of graphite oxidized to CO_2 per hour per gram of graphite remaining, were 0.06 to 0.25 hr^{-1}, and increased with increasing agitation and/or external surface area of the graphite. Corrosion of the stainless steel vessels was less than 80 mils per year at 300°C in 1 to 2 M HNO_3, but was excessively high when the acid concentration was higher. Pressurized aqueous combustion of graphite-base fuels appears technically feasible, but applicability of the method is seriously limited by the high pressure and high $HNO_3/(Th + U)$ ratio required, the corrosion rate, and the moderate rate of reaction. (auth)

4603 POLONIUM EXTRACTION BY SOLVENTS AND NORMAL POTENTIALS OF REDUCED POLONIUM. Haissinsky, M.; Pluchet, E. (Laboratoire Curie, Paris). J. Inorg. Nucl. Chem., 28: 2861-71(Dec. 1966). (In French).

The extraction of Po(II), produced by reduction with SO_2, from its chlorhydric solutions by hexone or acetylacetone, presents an apparent kinetic anomaly. Experiments on the partition of polonium between aqueous hydrochloric acid solutions and hexone in the presence of variable proportions of V^{4+}/V^{3+} or UO_2^{2+}/U^{4+} suggest the transitory formation of Po(III) and allow the determination of the standard potentials of the electrodes Po^{3+}/Po^{2+},Po^{4+}/Po^{3+} and Po^{4+}/Po^{2+}. The value found for the last potential is compared with other determinations. (auth)

4604 EXTRACTION OF TETRAVALENT METALS WITH di-(2-ETHYLHEXYL) PHOSPHORIC ACID. I. THORIUM. Tedesco, P. H.; de Rumi, V. B.; Gonzalez Quintana, J. A. (National Univ. of La Plata, Argentina). J. Inorg. Nucl. Chem., 28: 3027-33(Dec. 1966).

The distribution of thorium(IV) between sulfuric and nitric aqueous media and solutions of di-(2-ethylhexyl) phosphoric acid (DEHPA) in kerosene was studied. The effects of pH and of concentration of complexing anion in the aqueous phase on the exchange hydrogen–thorium and on the concentration of thorium and complexing anion in the saturated organic phase were determined. Some equations are proposed to interpret experimental data. (auth)

4605 PURIFICATION OF MULTICURIE QUANTITIES OF ^{147}Pm BY ION-EXCHANGE USING AMMONIUM α-HYDROXYISOBUTYRATE. Ritzman, R. L.; Barnes, R. H.; Sunderman, D. N.; Kircher, J. F. (Battelle Memorial Inst., Columbus, Ohio). J. Inorg. Nucl. Chem., 28: 2758-62(Nov. 1966).

A method for the purification of ^{147}Pm by ion exchange using diethylenetriaminepentaacetic acid (DTPA) and α-hydroxyisobutyric acid (α-HIB) at room temperature is given. The samples of ^{147}Pm were already free of contaminating radioisotopes but contained appreciable quantities of stable rare earths. The α-HIB was found superior to DTPA for separating Pm from other rare earth elements; however, the separation of Pm from Am required the use of DTPA. Using α-HIB as the eluent, nearly 98% of the total ^{147}Pm was recovered from the column and over 75% of this was contained in a volume of 300 ml. To satisfy the objective of the purification (high specific activity source material) recovery of ^{147}Pm from the column effluent solutions was required. This was accomplished by precipitation of Pm as the oxalate. The precipitate was ignited to the oxide Pm_2O_3 by heating 1 hour at 800°C. The procedure yielded nearly pure Pm source material. (D.H.M.)

4606 EXTRACTION OF CERTAIN ANIONIC ACTINIDE COMPLEXES FROM AQUEOUS SOLUTIONS BY LONG-CHAIN ALKYL AMMONIUM COMPOUNDS. I. THORIUM–SODIUM ALIZARIN 3-SULPHONATE SYSTEM. Sato, Taichi; Good, M. L. (Louisiana State Univ., New Orleans). J. Inorg. Nucl. Chem., 28: 2733-42(Nov. 1966).

The extraction of the anions of sodium alizarin 3-sulfonate (ARS) and the thorium–ARS complex by a long-chain quaternary salt was studied under various conditions of pH, organic diluent, concentration of reactants, and temperatures. The ARS extracted from aqueous solution in a 1 : 1 ratio with the quaternary compound. The spectra of the organic extract indicated that a single species was extracted, probably the acid form of the dye with the quaternary cation replacing the sodium ion. The 1 : 1 thorium–ARS complex extracted from aqueous solution in a 1 : 1 ratio with the quaternary salt. The spectra of the extracted thorium–ARS complex implied that the metal was probably chelated to the two phenolic oxygen atoms of the ARS. (auth)

4607 DISTRIBUTION OF SOME CATIONS BETWEEN IMMISCIBLE LIQUID PHASES IN THE $AlBr_3$–KBr SYSTEM. Ammon, R. v. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). J. Inorg. Nucl. Chem., 28: 2569-78(Nov. 1966). (In German).

The distribution behavior of fourteen metal halides between the liquid immiscible phases in the system $AlBr_3$–KBr was investigated at 200°C. Mainly ionic compounds prefer the polar, KBr-rich phase, whereas covalent-type halides are being enriched in the $AlBr_3$ phase. The highest separation factor obtained was 126 for Cs–Zr. Other separations seem to be possible, Zr–Nb or Nb–Ta, although only with multistage methods. Since UO_2 powders are easily dissolved by molten $AlBr_3$–KBr, as was shown with three different mixtures, the distribution coefficients previously measured could be confirmed for several fission products of an irradiated sample. The good solvent properties of molten $AlBr_3$–KBr mixtures with a molar ratio $K/Al < 1$ were demonstrated for one example ($BaBr_2$), whereas in a melt of equimolar composition solubility is practically nil. (auth)

4608 ROUTINE RECOVERY AND PURIFICATION OF ^{231}Pa. Brown, D.; Dixon, S. N.; Jones, P. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 28: 2529-33(Nov. 1966).

Solvent extraction of ^{231}Pa from sulfuric–hydrochloric acid mixtures was successfully employed for the routine recovery and purification of ^{231}Pa at concentrations up to 15 g ^{231}Pa/l. The method gives an excellent separation of protactinium(V) from several elements, including daughter nuclides. (auth)

4609 A DEVICE FOR THE LOW AND HIGH TENSION PAPER ELECTROPHORESIS. A METHOD OF RAPID SEPARATION OF RADIOACTIVE COMPOUNDS. Kapuscinski, Andrzej (Zakladu Radioizotopow Katedry Radiologii AM, Warsaw). Pol. Przegl. Radiol. Med. Nuklearnej, 30: 557-9(Sept.-Oct. 1966). (In Polish).

An apparatus for high and low voltage paper electrophoresis was designed and constructed. It was used for the separation of large and small molecular compounds on paper bands and on other media (e.g. the agar gel, the starch gel). (J.G.B.)

4610 INVESTIGATION OF THE URANIUM SORPTION AND SEPARATION FROM NITRIC ACID SOLUTIONS. Kazantsev, E. I.; Korobeinikov, V. L. (Ural Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 4, 89-94(1966). (In Russian).

Experimental studies of sorption and separation of U(IV) and other elements from HNO_3 solutions by AB-17 resin showed that AB-17 resin is incapable of sorbing Fe, Cr(III), Mn(II), Zn, Cd, and Ca from 0.1 to 11N HNO solutions, but small quantities of U(VI), Al, Bi, Zr, Ce(III), Be, Pb, Co, Ni, and Cu and considerable amounts of U(IV) can be sorbed by the resin. It was also shown that 0.1 to 11N nitric acid solutions elute Al, Bi, Ce(III), Be, Pb, Co, Ni, and Cu from the AB-17 resin. Uranium (VI) is eluted by 0.1 to 7N HNO solution. The amount of eluted uranium (IV) and zirconium is reduced with increased nitric acid concentration. Quantitative separation of U(IV) from Cu, Fe, Al, Bi, Ce, Ni, and Mg in HNO_3 by AB-17 resin is described. (R.V.J.)

4611 PAPER CHROMATOGRAPHIC SEPARATION DURING HYDROXIDE PRECIPITATION. Fabrikanos, A.; Lieser, K. H. (Technische Hochschule, Darmstadt, Ger.). Z. Phys. Chem. (Frankfurt), 51: 130-5(Nov. 1966). (In German).

The precipitation of cerium (III) hydroxide and of iron (III) hydroxide was followed by radio-paper chromatography at various pH values and as a function of time. The experimental results are presented in diagram and the rapidly resulting hydrolysis and the slowly occurring condensation reactions are discussed. (tr-auth)

4612 SEPARATION OF CARRIER-FREE ^{105}Rh FROM NEUTRON-IRRADIATED RUTHENIUM. Morris, D. F. C.; Khan, M. A. (Brunel Univ., London). Radiochim. Acta, 6: 110-11 (Oct. 1966).

Irradiated ruthenium powder is mixed with potassium hydroxide, carbon tetrachloride and water are added, and chlorine passed through the mixture until all the ruthenium is converged to RuO_4. The organic and aqueous phases are separated; the aqueous phase is acidified and ^{34}Fe and NH_4OH are added. The precipitate is dissolved in HCl and passed through an anion-exchange column. Tracer studies of the method showed that an overall yield of 85 to 87% is generally attainable. (M.C.G.)

4613 IONIC SPECIES OF PENTAVALENT PROTACTINIUM IN HYDROCHLORIC ACID SOLUTIONS. Scherff, Hans-Ludwig; Herrmann, Guenter (Univ., Mainz). Radiochim. Acta, 6: 53-61(Oct. 1966).

The partition of pentavalent protactinium between hydrochloric acid and di-iso-butylcarbinol (DIBC) was studied varying the following parameters: HCl concentration in pure HCl and in HCl–NaCl mixtures, protactinium concentration, and DIBC concentration using benzene as diluent. The composition of protactinium species in some organic phases was determined analytically. From these data the composition, relative formation constants, and abundances of protactinium species in both phases were derived. Protactinium forms, at low and medium HCl concentrations, highly oxygenated, cationic species, which are transformed at high acidities into highly chlorinated, anionic species. (auth)

4614 SEPARATION OF CARRIER-FREE ^{231}Th FROM ^{235}U. Gizon, A.; Lagrange, A.; Pelletier, A. M. (Centre d'Etudes Nucleaires, Grenoble, France). Radiochim. Acta, 6: 69-71(Oct. 1966). (In French).

^{231}Th and ^{235}U are separated by elution on Dowex 1X8 with 9N HCl. Th^{4+} ions are fixed on Dowex 50 or Amberlite IR-100 and extracted by oxalic acid. ^{231}Th is evaporated in a vacuum at 1700 to 1800°C on thin films of formvar. (auth)

4615 IMPROVEMENTS IN OR RELATING TO SOLVENT EXTRACTION PROCESSES. Mason, Tony (to United Kingdom Atomic Energy Authority). British Patent 1,047,201. Nov. 2, 1966. Filed Jan. 31, 1963.

A process is described for the recovery of U from ore concentrate. The ore concentrate is dissolved in nitric acid, the resultant crude uranyl nitrate solution is filtered and then purified by solvent extraction using TBP in odorless kerosene passed in counterflow to the flow of crude uranyl nitrate solution in a cascade of mixer-settler units, the impurities being retained in the aqueous phase as raffinate. Pure uranyl nitrate, which is taken up by the solvent during the extraction, is subsequently stripped from the solvent by weak nitric acid and proceeds to subsequent stages comprising evaporation, denitration, reduction to UO_2, hydrofluorination to UF_4, and magnesium reduction to massive metal. (P.C.H.)

4616 IMPROVEMENTS IN OR RELATING TO SEPARATION OF FISSION PRODUCTS. Healy, Thomas Victor (to United Kingdom Atomic Energy Authority). British Patent 1,047,232. Nov. 2, 1966. Filed July 12, 1963.

The separation of fission products, such as Rb, Cs, Sr, Ba, Zr, Nb, and rare earths, by solvent extraction is described. An aqueous acidic solution of the fission products resulting from the irradiation of a nuclear reactor fuel material is treated with an organic solution containing bis(2-ethylhexyl) phosphate to give an organic phase and an aqueous phase containing strontium. The organic phase is washed with at least one aqueous solution of a mineral acid. (P.C.H.)

EARTH SCIENCES

Geology

4617 SULFUR ISOTOPES IN MARINE CIRCULATION AND THE ^{35}S OF THE EARLY OCEANS. Nielsen, Heimo (Zentrallaboratorium fuer Geochemie der Isotope, Goettingen, Ger.). Geol. Rundsch., 55: 160-72(1966). (In German).

Circulation of sulfur isotopes from the sea by evaporation, rainfall, and runoff from land masses was studied. Because of isotope fractionation involved in the bacterial reduction of marine sulfate, sea sediments as a whole contain an excess of ^{32}S(δ^{34}S ≅ −0.5%), while marine sulfate is enriched in ^{34}S. Recent seawater has δ^{34}S ≅ +2.0%. Evaporite measurements indicate a still higher value in Cambrian, Silurian, and Devonian time. Then δ^{34}S decreased to about +1.1% in the Upper Permian and later increased again to the present value. Accumulation of abnormally large quantities of biogenic sulfides in slates of that era accounts for the high δ^{34}S value in the early Paleozoic. A considerable fraction of light sulfur has been returned to the oceans by weathering solutions of the Caledonian and Variscan orogenies, and in Mesozoic times another accumulation of slates took place. From a survey of the data available and from model estimations an attempt was made to construct the marine sulfur δ^{34}S evolution curve. Some practical consequences are outlined, such as information on balance of geological processes, interpretation of δ^{34}S data of normal rocks and ores, and sample dating in the case of doubtful age. (BBB)

4618 NEW APPLICATION OF RADIOCARBON DATING TO COLLAGEN RESIDUE IN BONES. Sellstedt, H.; Engstrand, L.; Gejvall, N.-G. (Museum of Natural History, Stockholm). Nature, 212: 572-4(Nov. 5, 1966).

The application of radiocarbon dating to collagen residue in bones is described. The organic (collagen) fraction of bone gives good results in radiocarbon analysis. Bone is cleaned and checked to ensure that no foreign protein is present. After it is ground up, a micro-Kjeldahl N determination is made. The protein content is calculated on the basis of the N content. All inorganic material is cleaned from the bone. The dried collagen residue is introduced into a combustion tube and subjected to routine ^{14}C analysis in a gas proportional counter using CO_2 as the counting gas. In age determination from bone samples, a half life of 5,570 yr is used. Archaeological age and ^{14}C age show close agreement. This method of age determination is useful in archaeology, zoology, physical geography and forensic science. (F.S.)

4619 POSSIBILITY OF THE ABSOLUTE AGE DETERMINATION OF ORGANIC SEDIMENTS BY THE IONIUM METHOD. Titaeva, N. A. (Moscow State Univ.). Geokhimiya, No. 10, 1183-92(Oct. 1966). (In Russian).

The study of the thorium, uranium and radium content in loose quaternary sediments of the south-western part of the Siberian platform has shown the connection of these element concentrations with the organic matter. The displacement of the radioactive equilibrium towards uranium may be used for the determination of the sediments under investigation according to the uranium/ionium ratio. It is necessary to subtract from the uranium and ionium concentrations respectively the ionium and uranium which were in equilibrium with the former at the moment of the sediment formation and to determine the age from the ratio of the obtained differences. (auth)

Meteorology

Refer also to abstracts 4473 and 4686.

4620 (AHSB(RP)-M-41) ASSESSMENT OF THE EFFECTS OF RELEASES OF ACTIVITY IN THE UPPER ATMOSPHERE DUE TO POSSIBLE BURN-UP OF ISOTOPIC POWER GENERATORS. Bryant, Pamela M. (Authority Health and Safety Branch, United Kingdom Atomic Energy, Harwell (England)). Sept. 1966. 11p. Dep. mn.

The potential applications of isotopic generators as sources of auxiliary power in space involve quantities of radionuclides sufficient to produce up to 1 kilowatt (electrical) of power. As the overall rate of future failures in the upper atmosphere, resulting in burn-up of all or most of the initial activity, is likely to be low, consideration is given to the possible consequences of burn-up of a single 1 kilowatt generator fueled with any of nine nuclides selected for study. Prediction of the activity in surface air and in milk is based on data from weapons tests, and predicted activities are compared with reference levels derived for the purpose. It appears that more than ten such generators fueled with plutonium-238 or strontium-90, the nuclides which would present more potential problems than the others studied, could be burned up without the reference levels being exceeded and that only if the rate of failure involving premature or unplanned burn-up were to be much greater than the low rate anticipated would some restriction on their use in space be necessary. (auth)

4621 (CEX-63.6.1) ORLANDO AREA (ARMS-II). Guillou, R. B. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Apr. 1964. Contract AT(29-1)-1183. 19p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

An Aerial Radiological Measuring Survey (ARMS) of the Orlando area was made between Feb. 11 and Feb. 21, 1963. The survey was part of a nationwide program to measure present environmental levels of gamma radiation. Approximately 4500 traverse miles were flown, at an altitude of about 500 ft above the ground, in the area which consisted of the land portion of a 100-mile square centered on the Kennedy Space Center. ARMS-II instrumentation was used in the survey. Data are presented as aeroradioactivity units, or areas with similar gamma radiation counting rates at 500 ft, at two map scales: (1) generalized at about 1 : 1,000,000 and (2) detailed at 1 : 250,000. The maximum aeroradioactivity in almost all the area was less than 400 counts/sec. In a few small areas along the east coast, the maximum counting rate was 500 counts/sec. Aerial measurements of ground radioactivity in the ARMS-II Orlando area were consistent with what was expected, considering the geology of the area. Artificial radionuclides were probably present in only small quantities because background gamma radioactivity was less than 200 counts/sec in many places. (auth)

4622 (COO-1340-8) LARGE SCALE ATMOSPHERIC TRANSPORT PROCESSES OF RADIOACTIVE DEBRIS. Final Report. Reiter, Elmar R. (Colorado State Univ., Fort Collins. Dept. of Atmospheric Science). Oct. 1966. Contract AT(11-1)-1340. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From December 1, 1963 to January 31, 1967, transport processes carrying radioactive debris from the stratosphere to the troposphere were investigated by means of individual case studies, by statistical techniques considering relatively long periods of time, and by a study of the behavior of the stratospheric polar night vortex during a "break-down" period. A summary of conclusions which have been published in previous reports is given. (auth)

4623 (LF-30) EVALUATION OF PARTICLE SIZING TECHNIQUES; COMPARISON OF COMPUTER PARTICLE SIZING PROGRAMS. Technical Progress Report. Posner, S.; Ettinger, H. J.; Pratt, O. R. Jr.; Moore, R. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Dept. of Aerosol Physics). July 1966. Contract AT(29-2)-1013. 16p. (CONF-660504-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From American Industrial Hygiene Assn., Annual Conference, Pittsburgh, Pa.

Aerosol sampling and sizing techniques from several different laboratories were compared in Part I of the evaluation. Results from the participants agreed within ±10% in defining count median diameter and geometric standard deviation. These were obtained via hand calculation of the data. Part II deals with comparing the same, or similar, data by computer programs. Four of these programs for analyzing particle size data are compared, and resulting differences are statistically evaluated. (auth)

4624 (RM-5100-TAB) DECAY OF A DISTURBANCE IN THE NATURAL DISTRIBUTION OF ^{14}C. Plesset, Milton S.; Dugas, Doris J. (RAND Corp., Santa Monica, Calif.). Nov. 1966. Contract AT(04-3)-414. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two models describing the decay of a carbon-14 excess injected into the atmosphere were developed; a chain model and a cyclic model, each having four reservoirs for exchangeable carbon. Time decay patterns resulting from each of these models are given. A direct way to summarize the biological effects of the addition of carbon-14 to the biosphere as a result of nuclear explosions in the atmosphere is to calculate the number of megatons required to give a dose equal to the undisturbed background dose from carbon-14. This doubling amount for $\eta = 1$ is 180 megatons over the first year following release, 290 megatons over the first generation, 2000 megatons for ten generations, and 370,000 megatons integrated over 100,000 yr. (F.S.)

4625 (SC-RR-66-597) EVALUATION OF THE MIDGET IMPINGER FOR SAMPLING U_3O_8 AND GRAPHITE AEROSOLS.

Everett, R. J. (Sandia Corp., Albuquerque, N. Mex.); Posner, S. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 13p. (LF-32). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Pyrolytic graphite and U_3O_8 dust distributions were prepared and aerosolized into a chamber equipped with balancing flow sampling ports. Aerosol samples were taken by standard midget impingers and Millipore type AA membrane filters. Particle size distributions were determined. From these data, comparisons were made to evaluate fracturing of particles by impingement, cluster breakdown, effects of sampling solutions, and the effect of ultrasound used to keep samples in suspension. Results indicate the existence of a critical time factor for counting the dust; this factor is caused by the breakdown of pyrolytic graphite particle clusters in solution. No significant fracturing due to impingement or ultrasonic stirring was observed. Ultrasonic agitation tends to accelerate the breakdown process in pyrolytic graphite suspensions. (auth)

4626 ENVIRONMENTAL RADIATION. Gustafson, Philip E. Argonne Nat. Lab. Rev., 3: 67-74(July 1966).

Environmental radiation is defined as the radiation around us and comes from both natural and man-made sources. The sources and distribution of environmental radiation are discussed. Measurements of external radioactivity and radiation and radioactivity in foods and internal radiation are reviewed. Metabolic and ecological studies are described and future trends in environmental radiation studies discussed. (F.S.)

4627 RECENT DEVELOPMENTS AND PROSPECTS OF METEOROLOGY. Fea, G. (Ministero della Difesa, Aeronautical, Servizio Meteorologico, Rome). Nuovo Cimento (1), 3: Suppl., 1081-1107(1965). (In Italian).

A panoramic and qualitative look is given to recent developments and prospects of meteorology with emphasis on various fields of research. The structure and circulation of the atmosphere, the dynamic meteorology and numerical predictions, microstructure of clouds, fogs, precipitations, and radioactivity and chemistry of the atmosphere are considered. (J.S.R.).

4628 ON THE METHOD OF MEASURING RADIOACTIVITY OF PARTICLES OF PRECIPITATION AND SOME PRELIMINARY RESULTS OF THESE INVESTIGATIONS. Styro, B. I.; Vebrene, B. K. (Academy of Sciences, Lithuanian SSR). Izv. Akad. Nauk SSSR, Fiz. Atmos. Okeana, 2: 1055-63(Oct. 1966). (In Russian).

A method of measuring radioactivity of raindrops and ice crystals by collecting on polished steel plates and chromatographic filters and later contacting with nuclear emulsions of the type A-2 is described. The number of nonradioactive droplets was determined by data in the 2π angle. It was shown that in continuous rains the percentage of nonradioactive droplets for one series of measurements is equal to 27 to 32% and for another one 42%. Radioactivity of individual droplets increases on the average but this growth reduces with the increase of droplet size. It was shown that the specific radioactivity of droplets increases by the exponential curve simultaneously with the decrease of droplet size. The mean value of relative evaporation of droplets was calculated by their falling out from the cloud to the earth's surface. (auth)

4629 GAMMA EMITTING RADIONUCLIDES IN SUBARCTIC VEGETATION DURING 1962-64. Haesaenen, Erkki; Miettinen, Jorma K. (Univ. of Helsinki). Nature, 212: 379-82(Oct. 22, 1966).

Results of analyses of γ emitting radionuclides, mainly ^{137}Cs, from Finnish Lapland and other parts of Finland are discussed. Thirty-two plant species, important as fodder for reindeer and cows, were studied and 114 samples were separately analyzed. It is shown that lichens take up ^{137}Cs from fallout almost quantitatively and retain it for years. No appreciable difference was found in uptake of ^{137}Cs by species growing in different soils. Equisetum fluviatile was found to be a suitable indicator plant to characterize the ^{137}Cs content of freshwater biota. (F.S.)

4630 ATMOSPHERIC DISPERSION AT BROOKHAVEN NATIONAL LABORATORY. Singer, Irving A.; Smith, Maynard E. (Brookhaven National Lab., Upton, N. Y.). Int. J. Air Water Pollut., 10: 125-35(Feb. 1966). (BNL-9577).

An analysis is provided of data collected, over the past 15 yr, relating to atmospheric dispersion at the Brookhaven National Laboratory site and its environs. These have included concentration measurements during all types of meteorological conditions at distances ranging from 10 m to 60 km. Used in these studies have been tracers such as oil fog, ^{41}Ar, and uranine dye. From these diverse experiments, a consistent treatment was developed, resulting in specification of the parameters suitable for use with common dispersion equations. Computed concentrations based on these parameters fit virtually all of the data quite satisfactorily, and are used routinely in the evaluation of various dispersion problems at the Laboratory. The Brookhaven parameters are related to the original data from which they were developed, and are compared with results obtained in experiments conducted at other sites. The dispersion patterns developed are discussed in detail and values of the parameters appropriate for various theoretical treatments are summarized. (BBB)

Mineralogy

4631 THE DEMESMAEKERITE, A U, Cu, AND Pb SELENITE HYDRATE. Cesbron, F. (Laboratoire de Mineralogie et de Cristallographie de la Sorbonne, Paris); Bachet, B.; Oosterbosch, R. Bull. Soc. Franc. Mineral. Crist., 88: 422-5(July-Sept. 1965). (In French).

Demesmaekerite is triclinic P1 or $P\bar{1}$ with a = 11.90 ± 0.03, b = 10.02 ± 0.03, c = 5.63 ± 0.02, $\alpha = 90°\ 11'$, $\beta = 100°\ 01'$, $\gamma = 91°\ 49'$, and Z = 1. The powder diagram indicates that the principal lines are 5.89 F, 5.42 FF, 3.34 F, 2.97 FFF. Fan shaped or prismatic lamina crystals are grouped according to [001] and flattened along (100) and perhaps (010). There is no distinct cleavage and the hardness lies between 3 and 4. The calculated density is 5.45 g/cm^3. The color varies from bottle green to clear olive green. The crystal has a positive biaxis with $n'_g = 1.910 \pm 0.005$ and $n'_p = 1.835 \pm 0.005$. A chemical analysis made on crystals free from impurities led to the formula $Pb_2Cu_5(SeO_3)_6(UO_2)_2(OH)_62H_2O$. Demesmaekerite was found in the cupro–Co ore deposits of Musonoi at Katanga associated with cuprosklodowskite, kasolite, malachite, guilleminite, chalcomenite, and a selenium digenite. (tr-auth)

4632 OCCURRENCE FORM OF URANIUM IN MICAS. Komarov, A. N.; Shukolyukov, Yu. A. (Lab. of Geology of the Precambrian, Leningrad). Geokhimiya, No. 11, 1322-30(Nov. 1966). (In Russian).

Three uranium occurrence forms of different origin have been established by studying uranium entrapped during mica crystallization, uranium existing in filmy uranium mineralization intruded into micas along the cleavage plane in the course of geological history, and uranium adsorbed on the cleavage planes of micas under recent conditions as a result of processes of hypergenesis. (auth)

4633 THORIUM ENTRANCE INTO MICAS. Naumov, G. B.; Polyakov, A. I.; Sergeev-Bobr, A. A. Geokhimiya, No. 11, 1331-9(Nov. 1966). (In Russian).

Thorium distribution was studied by chemical and autoradiographic methods and by selective leaching in natural biotites from igneous rocks and artificial fluophlogopites synthetized from the melt. The thorium content in natural biotites amounts to 7.5 to 10.0 γ/g in artificial fluophlogopites to 38 to 978 γ/g. The presence of proper thorium phases in the form of microinclusions and of evenly scattered (isomorphously entering) thorium has been established. In natural biotites a great part of radioactive elements (30 to 40%) is not bound up with the crystal structure of mica. (auth)

Oceanography

4634 CONTENT OF PROTACTINIUM AND THORIUM ISOTOPES IN OCEAN WATER. Kuznetsov, Yu. V.; Simonyak, Z. N.; Elizarova, A. N.; Lisitsyn, A. P. Radiokhimiya, 8: 455-8(1966). (In Russian).

Data on the content of thorium isotopes (^{230}Th and ^{232}Th) in the exposed part of the Pacific Ocean are reported. The ^{231}Pa concentration in waters of the exposed part of the Pacific Ocean was also determined. This concentration comprises not less than 5 to 7% from equilibrium with the ^{238}U dissolved in the water. (tr-auth)

4635 GEOCHEMICAL BALANCE OF RADIOACTIVE ELEMENTS IN BLACK SEA AND AZOV SEA. Nikolaev, D. S.; Lazarev, K. F.; Korn, O. P.; Drozhzhin, V. M. Radiokhimiya, 8: 469-76(1966). (In Russian).

The concentration of uranium in the Black and Azov Seas and adjacent reservoirs and in waters of primary river basins was determined. On the basis of the data obtained, the hydrochemical discharge and the residual elements of the uranium equilibrium (influx-discharge) in the Black and Azov Seas were calculated. The mean time of residence of uranium in the waters of the Black and Azov Seas was calculated as 4070 and 14.5 years, respectively. The velocity of the uranium precipitation on the bottom in deep water and shoal water levels of the Black and the Azov Seas was calculated to be 0.97×10^{-3}, 9.8×10^{-5}, and 1.29×10^{-3} g/m^2 per year. The calculation methods are described. (P.C.H.)

4636 TRANSPORT OF ^{90}Sr TOWARDS THE EQUATOR AT MID-DEPTHS IN THE ATLANTIC OCEAN. Bowen, Vaughan T. (Woods Hole Oceanographic Inst., Mass.); Noshkin, Victor E.;

Sugihara, Thomas T. Nature, 212: 383-4(Oct. 22, 1966). (NYO-2174-41).

Studies in physical oceanography, both by observation and by theory, seem to show that ^{90}Sr concentration in the middepths of the Atlantic Ocean are consistent with water circulation patterns and rates. Uniform concentrations of ^{90}Sr, found in 1961 in samples from depths of 1000 to 2500 m in intermediate latitudes in the Atlantic are compared to concentrations found in 1963. (F.S.)

4637 LOCAL VARIATION OF ^{13}C AND ^{18}O CONTENT OF MOLLUSK SHELLS AND THE RELATIVELY MINOR TEMPERATURE EFFECT IN MARGINAL MARINE ENVIRONMENTS. **Keith, M. L.; Parker, R. H. (Pennsylvania State Univ., University Park). Mar. Geol., 3: 115-29(Apr. 1965).**

Isotopic analyses (^{13}C and ^{18}O increments) of mollusk shells, arranged by environmental groups, are given. Oxygen isotopic compositions (^{18}O/^{16}O) of carbonates from marginal environments are difficult to interpret because the ^{18}O content depends on both the temperature and the oxygen isotopic composition of the water. Addition of ^{18}O deficient continental waters, and evaporative relative loss of $H_2{}^{16}O$, independently yield a positive correlation between salinity and ^{18}O content of the water in marginal environments. On the other hand, for waters of nearly constant isotopic composition, oxygen isotope fractionation between calcium carbonate and water gives a negative relation between water temperature and ^{18}O content of carbonates. The shell samples from the Mississippi delta and estuary are relatively deficient in ^{18}O, as compared with samples from the open gulf. Mississippi delta water temperatures are generally lower than those of nearby gulf waters. Therefore it seems apparent that the temperature effect, which by itself would yield higher ^{18}O/^{16}O ratios in shells from colder waters, is overwhelmed by the predominant effect due to addition of ^{18}O-deficient river water. Thus the ^{18}O increment of fossil shells cannot be used as a basis for conclusions regarding paleotemperatures in marginal marine environments of ancient seas. The carbon isotopic data can be more clearly and unambiguously related to environment. (TCO)

4638 GEOCHEMISTRY OF RADIUM ISOTOPES IN BLACK AND AZOV SEAS AND SOME ESTUARIES. **Lazarev, K. F.; Nikolaev, D. S.; Grashchenko, S. M.; Korn, O. P.; Drozhzhin, V. M.** pp 166-72 of Khimicheskie Protsessy v Moryakh i Okeanakh. Bruevich, S. B. (ed.). Moscow, Izdatel'stvo Nauka, 1966. (In Russian).

The tabulated data on ^{228}Ra and ^{226}Ra concentrations in various sections of the Black Sea, Azov Sea, and certain estuaries showed that the average concentration in the investigated parts of the Black Sea is $(1 + 0.1) \times 10^{-13}$ g/l and in the Azov Sea 1.4×10^{-13} g/l. An analysis was also made of radium concentration in silt at the bottom of these water basins and of the effects of rivers on the concentration of radioelements in the marine waters. (R.V.J.)

Seismology

4639 (AD-628901) LARGE APERTURE SEISMIC ARRAY. LASA SYSTEMS EVALUATION CONFERENCE (1ST), SEPTEMBER 11-13, 1965. **(Advanced Research Projects Agency, Washington, D. C.). Feb. 1966. 302p. (CONF-650980).**

A compilation of papers describing the Large Area Seismic Array (LASA) installation in Montana, which includes the ground installation, data transmission, and data acquisition systems is presented. The proposed long-period seismometer installation is discussed, as well as potential on-line and off-line processing systems for the Billings Data Center. Results from the installation are reported along with results from the Tonto Forest Seismological Observatory with instruments spaced over similar distances. The beam pattern is discussed and present theoretical data bearing on array geometry for additional arrays, if they are constructed, are presented. Prototype station requirements are developed reflecting current assessment of the desirable station configuration. (F.S.)

4640 (AECL-2597) EARTHQUAKE ENGINEERING. **Hake, G. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1966. 17p. (RCRS-100). Dep. mn. AECL $1.00.**

Basic principles of earthquake engineering as they may relate to nuclear safety are outlined and the dynamic seismic analysis to be done when designing earthquake resistant structures is described. The methods to obtain earthquake design spectra are described and information is presented on the frequency of occurrence of earthquakes in Eastern Canada and the use of this information for reactor site evaluation. (auth)

4641 PRIMARY GROUND DISPLACEMENTS AND SEISMIC ENERGY NEAR THE GNOME EXPLOSION. **Berg, Joseph W. Jr.; Trembly, Lynn D.; Laun, Philip R. (Oregon State Univ., Corvallis). Bull. Seismol. Soc. Amer., 54: 1115-26(Aug. 1964).**

Attempts were made to determine the energy in the primary seismic wave at distances between 0.3 and 10 km from the GNOME nuclear explosion. To accomplish this, it was necessary to make comparisons between a theoretical description of the seismic wave and the observed data in this range of distances. Near-source measurements of seismic waves from GNOME made by the U. S. Coast and Geodetic Survey were compared to the waveforms from a theoretical source derived by Blake. It is estimated that 75% of the seismic energy in the primary waves is contained in the first half-cycle of the ground displacement as shown on the seismograms from instruments located between 0.3 and 10 km from the explosion. The geometrical attenuation of the radiation field of the displacement wave is probably closely approximated by spherical divergence at ranges near the explosion. There is some evidence that a long-period displacement field may exist near the explosion as predicted by the theoretical model. However, there are not sufficient empirical data from the GNOME explosion to make a detailed comparison between theory and observation. Measurements of ground motion near an explosion are needed that will better define the initial seismic disturbance. (BBB)

4642 ELASTIC DISPLACEMENT OF PRIMARY WAVES FROM EXPLOSIVE SOURCES. **Berg, Joseph W. Jr.; Papageorge, George E. (Oregon State Univ., Corvallis). Bull. Seismol. Soc. Amer., 54: 947-59(June 1964).**

The results derived from observed data for compressional seismic waves generated by an explosive source are compared with those obtained by theoretical analysis. Equations derived from Blake's model of diverging waves from a point source were programmed for computer analysis. Variations of the displacement resulting from changes in the pressure function, propagational velocity, range, and cavity size were investigated. Results indicate that: a step pressure function used with this model gives displacements that closely approximate the displacements measured at 0.4 km from the GNOME nuclear explosion; near the source, long-period displacements are inherent with this model; the periods of the maximum Fourier transform amplitude of the radiation field are proportional to the equivalent cavity radius; the peak displacements scale to the two-thirds power of charge size for values of a radius of the cavity between 80 (0.5 Kt) and 600 m (275 kt); and between 0.1 and 3.0 cps, the amplitudes of given frequencies scale to the first power of charge size for values of a between 145 (3 kt) and 305 m (28 kt). In general, Fourier amplitudes at frequencies below the natural frequency of the cavity scale to the first power of charge size, and Fourier amplitudes at frequencies above the natural frequency of the cavity scale to a fractional power of charge size. It is suggested that this may be a good model with which to compare near-source observations of seismic phenomena. (BBB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 4624 and 5608.

4643 (TID-3522(8th Rev.)) PLOWSHARE: A SELECTED, ANNOTATED BIBLIOGRAPHY OF THE CIVIL, INDUSTRIAL, AND SCIENTIFIC USES FOR NUCLEAR EXPLOSIVES. Gerber, Carl R. (Division of Peaceful Nuclear Explosives (AEC), Washington, D. C.); Voress, Hugh E. (comps.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1966. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This bibliography presents annotated references arranged by subject. A guide to where the reports may be obtained and their cost, a separate listing of the films available, and an index of where information on specific projects may be found follow the annotated references. Author and report number indexes are also included. (auth)

4644 (UCRL-13242) ECONOMICS OF UNDERGROUND GAS STORAGE IN CAVITIES CREATED BY NUCLEAR EXPLOSIONS. Final Report. (California Univ., Berkeley. Coll. of Engineering). Oct. 13, 1966. Contract W-7405-eng-48. 5p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In an appropriate geologic setting underground chimneys created by nuclear explosions offer excellent possibilities for storing gas. For devices with yields in the range of 10 to 100 kt, total storage volume varies from 0.1 to 1.4 billion ft^3/explosion. It appears that nuclear storage may be competitive with liquid (LNG) storage. (F.S.)

4645 (UCRL-14429) EFFECTS OF NUCLEAR EXPLOSIONS ON GAS WELL HEAD AND GAS FIELD EQUIPMENT. Rabb, David D. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 23, 1965. Contract W-7405-eng-48. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Two simulated well head configurations consisting of welds, valves, pipes, and casing survived nuclear explosions when installed on the surface at 950 and 1200 ft from the 1300 ft deep emplacement hole for a 10 kt explosion and a second explosion of 5 kt at a depth of 500 ft. Well head equipment can survive without damage in regions where peak surface accelerations are in the order of 5 g. These experiments did not provide information relative to the survival of existing wells under pressure in the area close to a nuclear explosion. (F.S.)

4646 PRODUCTION OF TRANSPLUTONIUM ELEMENTS IN THERMONUCLEAR EXPLOSIONS. Fields, Paul. Argonne Nat. Lab. Rev., 3: 65-6(July 1966).

The production and isolation of fermium and einsteinium in the MIKE thermonuclear test in 1952 are reviewed. Attempts to produce the higher actinides in underground tests are summarized. Results of BARBELL and PAR tests in producing elements through element 100 and masses through 257 are summarized. Plans for producing β stable isotopes of elements 100 through 108 and the use of targets of ^{238}U, ^{242}Pu, ^{243}Am, ^{244}Cm, ^{248}Cm and ^{252}Cf are considered. (F.S.)

Facilities and Equipment

Refer also to abstracts 4679, 5210, and 5291.

4647 (RL-GEN-1249) AN ELECTRICALLY CONTROLLER JET SYSTEM FOR REMOTE OR AUTOMATIC JET OPERATION. (HWIR-1539: AN INVENTION DESCRIPTION). McMahill, Clark E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Aug. 15, 1962. Contract AT(45-1)-1350. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An electrically controlled jet system, which controls the operation of pneumatic valves by electrical switching is described. Components include three electrically operated air switches, valves, and relays. Cycle tests have proved the system to be reliable. It will be installed in conjunction with a vessel requiring automatic liquid transfer upon reaching a predetermined level or quantity. (F.S.)

4648 ECONOMICS OF DESALINATION. Baron, S. (Burns and Roe, Inc., New York). IEEE (Inst. Elec. Electron. Eng.), Spectrum, 3: No. 12, 63-70(Dec. 1966).

In an analysis of the thermodynamics of dual-purpose desalination plants, it is apparent that the base-loaded plant with noncondensing turbine provides the most economic approach to desalination even though new storage capacities will be required. Conveyance of water to existing reservoirs and variable operation of the water facility offer no economic advantages. Desalination of water is too expensive for agricultural applications, but it provides a promising source of fresh water for certain areas with special water problems where conventional supplies are inadequate to meet the needs of growing populations and increased industrialization. Thermodynamic comparisons of single-purpose power plants (fossil and nuclear); single-purpose water plants (fossil or nuclear); noncondensing dual-purpose (fossil and nuclear); and condensing dual-purpose (nuclear) plants are given. (F.S.)

4649 OPTIMIZATION OF THE PRIMARY PIPING AND THE STEAM GENERATOR FOR GAS-COOLED NUCLEAR REACTOR SYSTEMS. Lys, L. A.; Lang, P. M. (Swiss Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). Neue Tech., 8: 295-8(Oct. 1966).

In the design of gas-cooled nuclear power plants, it is advantageous to avoid the necessity of optimizing the parameters of the primary piping and of the steam generator along with the principal design variables of the plant. The characteristics of the optimum piping and steam generator are developed analytically as a function of coolant pressure, temperature, and flow rate, and as a function of steam generator duty and mean temperature difference. With these results, it is possible to optimize the entire plant without detailed consideration of the piping and steam generator systems. Costs of these systems are expressed in terms of their main design parameters and in terms of primary-system variables. By equating the derivatives of these cost functions with respect to the design parameters to zero, optima are found in terms of the primary-system variables. Substitution into appropriate expressions for the pressure drops, pumping powers, dissipations, and capital costs of the piping and steam generator then gives the desired results. (auth)

4650 CIVIL ENGINEERING PROBLEMS IN THE CONCEPTION OF THE 250 MW(e) HEAVY WATER REACTOR OF THE SNA. Lafitte, R.; Khan, M. Hussain (Bonnard and Gardel, Ingenieurs-Conseil, Lausanne, Switzerland). Neue Tech., 8: 269-88(Oct. 1966). (In French).

Civil engineering problems connected with the different solutions of conventional (pressure tube) heavy water type reactors of 250 MW(e) are examined. Different solutions of integrated types of reactors where the heat exchangers and the core are both housed in a prestressed concrete pressure vessel are discussed in detail from the civil engineering point of view. Two methods of analysis of the pressure vessel based on the theory of thin shell and on the dynamic resolution of finite difference equations with the help of an electronic computer are analyzed and compared. A cylindrical pressure vessel for the 250 MW(e) SNA reactor having an internal pressure of 60 kg/cm^2 was designed. After analyzing the pressure and temperature stresses, the system of prestressing cables is determined. The behavior of the vessel under all conditions of operation was analyzed. Problems concerning the security against reversible cracking and rupture are also discussed. (auth)

4651 INVESTIGATIONS ON TRAPPED FLUX IN CRYOGENIC CONTINUOUS FILM MEMORY CELLS. Kadereit, H. G. (Siemens and Halske Research Lab., Munich). IEEE (Inst. Elec. Electron. Eng.) Trans. Magnet., MAG-2, 402-6(Sept. 1966).

Measurements on trapped flux in superconducting continuous film memory cells in the stationary case are reported. For investigating the frozen-in magnetic field with the drive currents switched on and off, a superconducting tin film is used as a probe. The memory cell is deposited in the usual way with the sense line consisting of tin. With an adequately chosen sense current, the voltage along the sense line changes depending on the field which penetrates the memory plane. This method allows observation of small or slow flux changes like creation and migration of vortexes. Effects of this kind cause, for instance, flux degradation by half select pulses. The method is further used to investigate the differences in trapped flux when slow and fast rise time pulses are applied. These results show that observation of the trapped flux in superconducting continuous film memory cells, using the resistance drop along a superconducting sense line, is an especially good method for gaining information about the stability and reproducibility of trapped flux. In addition to inductive measurements where a sense signal can only be found if an avalanche penetration takes place, slow processes can be investigated. (BBB)

4652 INVESTIGATION OF THE HOMOGENEITY OF NEUTRON-ACTIVATED IRON-MANGANESE OXIDE MIXTURES BY MEASURING THE ^{59}Fe GAMMA RADIATION. Roethe, A.;

Roethe, K.-P.; Wagner, K. (Institut fuer Physikalische Chemie, Berlin. VEB Keramische Werke Hermsdorf, Hermsdorf, Ger.). Isotopenpraxis, 2: 386-7(Oct. 1966). (In German).

The ^{59}Fe gamma-radiation of a statistically significant number of neutron-activated iron-manganese oxide samples was measured. For estimating the homogeneity, the standard deviations of the series of measurements were compared with that of the measuring method, and the number of measuring data lying outside the range of the measuring technique has been determined. It was shown that measurements of this kind are suitable for testing sample homogeneity. (auth)

4653 SERVO CONTROLLED MANIPULATOR. Jones, Leon; Thousand, John Louis (to Northrop Corp.). British Patent 1,046,689. Oct. 26, 1966. Filed June 16, 1965.

A manipulator and apparatus for remotely controlling manipulators are described. The apparatus for manipulator hand control includes a glove with at least one finger, a bladder mounted in the glove, means for sensing the rotational position of the manipulator hand, means for sensing the rotational position of the finger, and means for inflating the bladder in accordance with the difference between the outputs of the sensing means to generate tactile sensations in the glove simulating the pressure applied by the manipulator hand to the object when the device is in operation. The bladder gives the operator a kinesthetic sensation simulating the force being applied on the controlled object, preventing the use of excessive force. (F.S.)

4654 METHOD FOR OBTAINING FORCED LIQUID CIRCULATION. (to Institutt for Atomenergi). British Patent 1,047,423. Nov. 2, 1966. Priority date Mar. 27, 1963, Norway.

A method is described for obtaining forced circulation of a liquid in thermodynamic systems such as in reactors, vapor generators, and heat pumps. Forced liquid circulation in a flow circuit is obtained by heating a liquid in one portion of the circuit to its vaporization temperature, mixing the vapor with an externally supplied liquid to condense part of the vapor, and converting a portion of the heat content of the vapor to kinetic energy. The kinetic energy is used for propulsion of the liquid through the circuit. Efficient circulation is obtained without a pump and energy not used stays in the system. Reactivity of a reactor can be varied by adjusting the temperature and pressure of the liquid in the external liquid circuit. (F.S.)

4655 ION ROCKET ENGINE. Boden, Robert H. (to North American Aviation, Inc.). U. S. Patent 3,279,176. Oct. 18, 1966. Filed July 31, 1959.

A propulsion system applicable to space vehicles which provides high-impulse but low-thrust using accelerated ions to develop the rocket engine thrust is described. The system consists of an ion rocket thrust chamber, a source of ion propellant, means for generating ions from the propellant source, means for extracting the ions, and means for accelerating the ions to the exhaust velocity desired. Alkali metals, such as cesium, rubidium, and thorium may be used as a source of positive ions in the system. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstract 5702.

4656 (BM-RI-6856) FILM COEFFICIENTS OF HEAT TRANSFER FOR HELIUM AT 2,000 DEG TO 2,500 DEG F IN TURBULENT FLOW. Coates, N. H.; Galli, A. F. (Bureau of Mines, Washington, D. C.). 1966. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Bureau of Mines determined average film coefficients of heat transfer for helium flowing through smooth, water-cooled tubes at Reynolds numbers of 5,000 to 25,000, helium inlet temperatures of 1,600° to 2,600°F, average temperature difference across the helium film of 800° to 1,300°F, and heat flux to 215,000 Btu/(hr)(sq ft). Since helium was the only gas used, the ranges of values for physical properties of the fluid are limited—thermal conductivity from 0.15 to 0.20 Btu/(hr)(sq ft)(°F/ft), viscosity from 0.082 to 0.104 lb/(ft)(hr), and Prandtl number from 0.63 to 0.68. Four equations, three of them dimensionless, were used to correlate these coefficients with other properties of the helium—bulk temperature, film temperature, dimensionless parameters based on temperature, and the ratio of wall temperature to bulk temperature. Values of the average inside film coefficient of heat transfer determined from these equations agree within 10 percent. (auth)

4657 (HASL-180) PRESSURE DROP ACROSS SHARP END CAPILLARY TUBES. Rimberg, David (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Nov. 1966. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

In fluid flow problems it is often necessary to evaluate the overall pressure drop across sharp end tubes. For laminar flow, Poiseuille's Law is used as an approximation of the actual pressure drop. For accurate work the following three corrections must be applied: the difference in pressure between the still inlet fluid and the moving fluid within the tube has to be accounted for; the effect of a nonuniform velocity distribution across the pipe will contribute to a pressure loss; and the losses due to end effects must also be included. An equation was developed which not only includes these corrections for pressure drop but also the loss associated with frictional resistance within the tube. By allowing air to flow through many capillary tubes of various lengths and diameters, with Reynolds numbers less than 2100, this new equation was tested. The pressure drop across the capillary was accurately determined with special experimental equipment. This pressure drop was then compared to the pressure drop obtained analytically. The result of this comparison proved that for laminar flow the aforementioned corrections must be considered in any precise determination of the pressure difference which occurs with abrupt changes in cross-section. (auth)

4658 (LA-DC-7109(Rev.)) FORCED CONVECTION HEAT TRANSFER TO HYDROGEN, 60 TO 500 DEG R. Williamson, K. D. Jr.; Bartlit, J. R. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A modified Dittus—Boelter equation is given for the prediction of heat transfer coefficients to flowing hydrogen in the temperature range 100 to 500°R. The equation predicts the coefficients over the range 60 to 100°R as well as any other equation. The modified equation relies on bulk properties and avoids the need for iterative calculations inherent with equations using properties evaluated at wall or film temperatures. (F.S.)

4659 (NASA-SP-131, pp 201-38) POTASSIUM RANKINE SYSTEMS TECHNOLOGY. English, Robert E.; Cummings, Robert L.; Davies, Robert L.; Moffitt, Thomas P.; von Glahn, Uwe H. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

The technology of a potassium vapor Rankine cycle turbogenerator power system is reviewed. Thermodynamic data, heat transfer coefficients and pressure drop data of boiling and condensing potassium, are adequate for the design of such a powerplant. Additional data on the problems of boiling stability, turbine blade erosion, design information on bearings, seals, pumps, and electrical materials are needed before major components can be designed and constructed. (F.S.)

4660 (SU-247-12) LAMINAR FILM CONDENSATION ON SURFACES NORMAL TO BODY OR INERTIAL FORCES. Nimmo, B. (Stanford Univ., Calif. Dept. of Mechanical Engineering). Sept. 1966. Contract AT(04-3)-247. 48p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Laminar film condensation on a flat, isothermal plate which is normal to body or inertial forces results in a flow of condensate toward the edge of the plate due to a hydrostatic pressure gradient. Various assumptions are introduced to reduce the general momentum and energy equations to a tractable form. The differential equation for the film thickness as a function of position along the plate is solved assuming that the film thickness at the plate edge is known. Methods of calculating local and mean film heat transfer coefficients are presented along with criteria which indicate the range of variables for which the solution is valid. Simplified approximate equations are given for calculation of the mean Nusselt number. Application of the analysis, in addition to the horizontal plate, includes rotating cylindrical surfaces whose radius is large compared to the condensate film thickness. (auth)

4661 (UCRL-50123) TWO-PHASE PRESSURE DROP: A LITERATURE SURVEY AND CORRELATION ANALYSIS. Caughron, Raymond D. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1966. Contract W-7405-eng-48. 89p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Methods for predicting pressure drops in two-phase flow systems were investigated. A literature survey covers the historical development and current status of the subject. Flow classification, technical terms, important equations, and interrelationships among variables pertinent to the study of two-phase flow were reviewed. A general description of two-phase pressure drop is presented including the energy and momentum equations. Prediction methods were categorized according to method of approach (empirical, dimensional, similarity, mathematical analysis applied to simplified physical models, and approximation theory). Numerical examples were included to demonstrate the Dukler and

Lockhart–Martinelli approaches. Comparison methods by Dukler, Anderson and Russell, and Hughmark with tables are included. Baker's chart and method of predicting two-phase flow regimes, experimental steam–water data, and computer sub-routines for the Homogeneous and Lockhart–Martinelli methods are given in the Appendices. (auth)

4662 (ANL-Trans–392) APPLICATION OF THE VARIATIONAL METHOD FOR SOLUTION OF HEAT CONDUCTION PROBLEMS WITH INTERNAL HEAT SOURCES. Fain, A. M. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Inzh. Fiz. Zh., 10: No. 5, 668-75(1966). 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The variation method considered which reduces the solution of the two-dimensional heat-conduction equation to a set of linear differential equations is very simple and shows good convergence. The method suggested for choosing the coordinate functions and the possibility of application of the simplest integrators for calculation of coefficients of Euler's equation set make this method convenient for practical use. (auth)

4663 (UCRL-Trans–10064) THE DETERMINATION OF LOCAL AND MEAN HEAT TRANSFER COEFFICIENTS IN TUBES AT HIGH HEAT–FLUX DENSITIES. Hufschmidt, W.; Burck, E.; Riebold, W. Translated by B. J. Hazzard for Lawrence Radiation Lab., Livermore, from Int. J. Heat Mass Transfer, 9: 539-65 (1966). 70p. Dep. mn. JCL $6.60 fs, $2.30 mf.

In the determination of local and mean heat transfer coefficients of flowing media in or on directly electrically heated tubes, two measuring processes are commonly used in order to determine the nonmeasurable temperature T_w of the cooled surface: either the temperature T_{is} of the noncooled side of the tube wall is measured with thermocouples, or the mean wall temperature T_m is determined from the measured electrical resistance of the tube. It is shown that, because of the principle of measurement, the second process can lead to errors if it is desired to carry out local measurements. The calculation of the temperature differences $(T_{is} - T_w)$ and $(T_m - T_w)$ has been carried out with the aid of the solution of the thermal conductivity equation with heat sources and temperature-dependent characteristics of the wall material. It was shown that in the technically interesting range a simplified solution starting from constant, mean, material characteristics, yields only slight deviations from the "accurate" solution (given by an IBM 7090 digital computer). (auth)

4664 EMPIRICAL CORRELATION OF FACTORS INFLUENCING DEPARTURE FROM NUCLEATE BOILING IN STEAM–WATER MIXTURES FLOWING IN VERTICAL ROUND TUBES. Pasint, D.; Pai, R. H. (Foster Wheeler Corp., Livingston, N. J.). J. Heat Transfer, 88: 367-75(Nov. 1966).

An empirical correlation of forced convection Departure from Nucleate Boiling (DNB) for steam–water mixtures between 500 and 3000 psia in uniformly heated vertical tubes is proposed. DNB quality is expressed in terms of pressure, mass flow, inlet enthalpy, heated length from inlet to DNB point, and tube dia. Experimental data at 2000–3000 psia, 250,000–1,000,000 lb/hr/ft^2 mass flow, and 40,000–180,000 Btu/hr/ft^2 heat flux, obtained from a 6 ft long, $^3/_4$-in.-ID electrically heated vertical tube, are correlated with other published results ranging from 500 to 2000 psia. (auth)

4665 THERMAL PERFORMANCES OF RADIATIVE AND CONVECTIVE PLATE-FINS WITH MUTUAL IRRADIATION. Okamoto, Yoshizo (Japan Atomic Energy Research Inst., Ibaraki). Bull. JSME (Japan Soc. Mech. Eng.), 9: 150-65(1966).

Heat exchangers, space vehicle radiators, and fuel elements of gas-cooled nuclear reactors require the use of finned surface for high-flux heat transfer. The finned surface emits the radiative and convective energy to other surfaces of an enclosure and a gas. Thermal analyses thus far have been carried out for an isolated fin and have neglected the mutual irradiation between the surfaces. Thermal performances of radiative and convective plate fins are systematically analyzed on the basis of a derived steady-state integral differential equation. This was solved for a wide range of values of the normalized parameters. Angle factors of gray surfaces in the fin were calculated. In using a numerical conversion method expressed as a matrix form, overall configuration factors of the fin were calculated. The equation was solved by the use of a digital computer. The temperature, heat transfer ratio, and heat transfer rate were obtained for various values of dimensionless parameters. The heat transfer mechanism of the plate fins was classified into five cases. In each case, the performance of fin is discussed. An approximate equation is introduced. It is concluded that the temperature distribution of the plate fins becomes flat because of the mutual irradiation, therefore, the efficiency is larger than that of a single sheet of a plate fin. (BBB)

4666 TURBULENT FREE CONVECTION IN NEAR-CRITICAL WATER. Larson, J. R. (Phillips Petroleum Co., Idaho Falls, Idaho); Schoenhals, R. J. J. Heat Transfer, 88: 407-14(Nov. 1966).

Heat transfer from a vertical flat plate by turbulent free convection to water near its thermodynamic critical point was studied analytically and experimentally. The analytical method of solution involved an integral technique as well as assumptions dealing with Reynolds analogy, the Blasius wall shear stress, and suitable velocity and temperature profiles. Measurements were made of the heat flux from a platinum ribbon suspended in a pressure vessel containing the test water. The ribbon was heated electrically by direct current. Its temperature was determined by resistance measurement combined with a previously obtained resistance–temperature calibration. The experimental results indicate reasonable agreement with the analytical prediction but could be improved with a better method of evaluating the Prandtl number. A correlation of the experimental data was developed and is given in terms of the usual dimensionless parameters. (auth)

Isotope Technology

Refer also to abstracts 4620, 4716, 4891, 4892, 5595, and 5608.

4667 (AECD-RB–3) SERICULTURE IN EAST PAKISTAN AND ROLE OF ATOMIC ENERGY FOR ITS IMPROVEMENTS. Hossain, M. M.; Mallik, M. U.; Mollah, S. A. (Atomic Energy Centre, Dacca (Pakistan)). July 1966. 17p. Dep. mn.

The use of atomic energy to improve sericulture in East Pakistan by irradiation of silk worms to stimulate growth, to replace the hot air treatment to kill the pupae inside the cocoon which injure the silk, and to produce mutations from ionizing radiation to improve the commercial varieties of silk worms is discussed. (F.S.)

4668 (LA-DC–7908) THE SEPARATION OF ^{3}He FROM ^{3}He–^{4}He MIXTURES. Sherman, Robert H. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 4p. (CONF-660816-4). DTIE.

From 10th International Conference on Low Temperature Physics, Moscow, USSR.

A distillation-type apparatus is described, which has a high output of pure ^{3}He with little waste. The stillpot is a cylindrical copper container to which is attached a small heater of ~800Ω resistance. The vapor reflex column consists of Inconel tubing wound in an 8-turn spiral 6 cm dia. This tube is immersed directly in the ^{4}He bath. The tube is used for both filling, reflux, and removal of the purified ^{3}He. In an experiment, 8.7 NTP liters of 99.9997% ^{3}He were collected in 1 hr and 54 min or 5.6 l/hr at a molar reflux ratio of 22.1. The next 8.8 liter batch from the same filling of the still was 99.985% ^{3}He. (M.C.G.)

4669 (NASA-SP-131) SPACE POWER SYSTEMS ADVANCED TECHNOLOGY CONFERENCE [HELD AT] LEWIS RESEARCH CENTER, CLEVELAND, OHIO, AUGUST 23-24, 1966. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.). 1966. 284p. (CONF-660822). CFSTI $3.75 cy, $1.50 mn.

Ten papers are presented on advances in the technology of space power systems. Major topics covered include batteries and fuel cells, solar cells, isotope thermoelectric generators, Brayton cycle technology, SNAP-8 development status, potassium Rankine systems technology, thermionics, and applications of power systems to specific missions. Separate abstracts were prepared for six of the included papers. (F.S.)

For abstracts of individual papers see: 4659, 4670, 4671, 4938, 5110, and 5673.

4670 (NASA-SP-131, pp 73-93) ISOTOPES AND ISOTOPE THERMOELECTRIC GENERATORS. Schulman, Fred (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

The advantages and disadvantages of ^{60}Co, ^{90}Sr, ^{147}Pm, ^{170}Tm, ^{210}Po, ^{242}Cm, ^{244}Cm and ^{238}Pu relative to their use in isotopic space power systems are discussed. The availability of these isotopes is reviewed. Nimbus B, employing two SNAP-19 generators, and the Apollo Lunar Surface Experiment Package (ALSEP) using SNAP-27 are discussed. (F.S.)

4671 (NASA-SP–131, pp 95-145) BRAYTON CYCLE TECHNOLOGY. Stewart, Warner L.; Anderson, William J.; Bernatowicz, Daniel T.; Guentert, Donald C.; Packe, Donald R.; Rohlik, Harold E. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

The use of the Brayton cycle for space power systems, including design considerations, is reviewed. Performance and packaging of the turbomachinery and generator are discussed. The reliability, efficiency, and magnetic unbalance of the electric generator in its conversion of shaft power into electric power are evaluated. The uses of solar, isotopic, and nuclear reactor heat sources are compared. (F.S.)

4672 (ORO-3224-6) A STUDY OF FLUORESCENT EXCITATION USING ISOTOPIC X-RAY EMISSION. Martin, Troy C.; Blake, Kenneth R.; Morgan, Ira Lon; Parker, C. Varren Jr. (Texas Nuclear Corp., Austin). June 30, 1966. Contract AT (40-1)-3224. 66p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The major factors involved in the utilization of the isotopic X-ray fluorescent analysis technique were investigated. These include matrix enhancement and absorption effects and beta-excited X-ray source efficiencies. The errors due to matrix effects in the energy region less than 5 keV have been found to be quite severe in several applications. The limitations imposed upon this technique in the low energy region due to relatively poor resolution of the gas spectrometer can be overcome somewhat by the use of X-ray filters. In addition, the use of a small beta-excited photon source permits the discrimination against X-rays from elements of higher atomic number in a given matrix. Preliminary results on the production of tritium-excited X-ray sources by the ion bombardment technique appear promising. (auth)

4673 (CEA-tr-A-1852) LE TUBE DE SEPARATION. XXV. REPARTITION DES CONCENTRATIONS D'UN MELANGE D'ISOTOPES A CONSTITUANTS MULTIPLES DANS UNE COLONNE DE THERMODIFFUSION. (Separation Column XXV. Separation of Concentrations of Isotopes in a Thermal Diffusion Column). Clusius, K.; Varde, E. Translated into French from Helv. Chim. Acta, 45: 2273-81(1962). 26p. (In French). Dep. mn. JCL $2.60 fs, $0.98 mf.

The general scheme of the variation of the concentration or of the molar fraction of various isotopes of an element, in a separation column, was established as a function of the ζ coordinates along the length of the column, by taking in the first approximation the thermal diffusion coefficient proportional to the difference between the mass numbers of the two isotopes or isotope molecules. If the composition of the natural mixture is maintained unchanged at the origin point of the installation, the distribution of the isotopes of an element determined along the separation installation can be given directly in a $\gamma\zeta$ diagram. The curves corresponding to this open circuit operation are given for the elements Kr, Xe, S, and Se. The results showed that: the function representing the distribution of the isotope concentrations has, in general, no symmetry character; in agreement with experiment, only the two boundary isotopes of a series, that is, that of highest mass number and that of lowest mass number, can be obtained directly in the pure state; the median isotopes always pass through concentration maxima, which, in the first-order approximation, are found exactly at the point where mean mass number $\tilde{m} = \sum_{k=1}^{n} m_k \gamma_k$ is identical to the mass number m_1 of the isotope considered: two concentration curves always intersect at a single point; the $\gamma\zeta$ diagrams, in the case of first-order approximation, are the same for all the compounds of the same element, for example, H_2S, D_2S, $^{12}C^{16}OS$, $S^{16}O_2$, SF_6, as long as molecules that contain only a single atom of the element are considered, apart from the other pure elements; and the addition of an auxiliary gas introduces entirely new conditions because the thermal diffusion coefficients vary with concentration. (tr-auth)

4674 GERMAN IMPORT STATISTICS FOR RADIOACTIVE MATERIALS. Schmidt-Kuester, W.-J. Atomwirtschaft, 11: 432-3(Aug.-Sept. 1966). (In German).

The use of radioactive materials for research, technology, and medicine increased in 1965 much more rapidly than expected. The imports yielded nearly the same quantity of activity as that imported in the preceding nine years. In addition to the much larger number of radioisotopes, which were used in greater quantities, especially impressive were the increases in the use of ^{192}Ir (materials testing), tritium, and ^{147}Pm (luminous paints), as well as ^{90}Sr (isotope batteries, which together reached more than 85% of the total imported activity with the exclusion of radiation sources over 50 curies. (tr-auth)

Materials Testing

Refer also to abstracts 4652, 4720, 4938, 4952, and 5638.

4675 (N-66-29973) INFRARED TESTING OF ELECTRONIC COMPONENTS. Final Report, April 5, 1965–June 5, 1966. Randle, W. R.; Chadderdon, G.; Hartman, T. L. Jr. (Martin Co., Orlando, Fla.). Contract NAS8-20131. 115p. (NASA-CR-76080; OR-8347). CFSTI $3.00 cy, $0.65 mn.

The feasibility of developing an infrared radiation nondestructive test technique for electrical/electronic devices was investigated. The phases included are: (1) a state-of-the-art survey of industry and government organizations, (2) testing conformal coating materials to standardize surface emissivity, and (3) determining the use of infrared in various actual applications. A relationship between infrared radiation and life expectancy was established. It was found that increased operating temperature has a deleterious effect on transistor life expectancy, but also design and process variables may have a significant effect. Infrared fingerprinting of the operating components on a printed circuit board for thermal derating analysis and for troubleshooting was proven to be feasible, and was successfully employed in: (1) locating the hotter components on a printed circuit board, (2) evaluating the effects of relocation, and (3) accurately evaluating a variety of heat sink configurations and transistor mounting techniques. The requirements for application of infrared and its limitations are identified. (STAR)

4676 EXPERIMENTAL CONSIDERATIONS FOR POLAROID FILM X-RAY PHOTOGRAPHS. Peters, E. T.; Kulin, S. A. (ManLabs, Inc., Cambridge, Mass.). Rev. Sci. Instrum., 37: 1726-9(Dec. 1966).

Polaroid type 57 sheet film (ASA 3000) was evaluated as a means for recording x-ray Laue and pinhole diffraction photographs; both transmission and back reflection geometries were employed. Consideration was given to the effect of x-ray tube target material, tube voltage and current, exposure and processing times, collimator size, and specimen-to-film distance on resultant pattern quality. Examples are given which illustrate the ability to obtain high quality Polaroid film patterns in considerably less (5 to 20%) time than is required for comparable wet process films. (auth)

Radioactive Material Handling

Refer also to abstract 4653.

4677 (AAEC-TM-319) A VACUUM HOT PRESS FOR USE IN A GLOVE BOX. Lawrance, J. J.; Young, J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr. 1966. 6p. Dep. mn.

This note describes a simple hot press suitable for use in either a vacuum or a controlled atmosphere. The press can be easily set up in a glove box. (auth)

Vacuum Engineering

Refer also to abstract 4897.

4678 (INR-740/XVII/PP) KASKADOWY UKLAD WYSOKOPROZNIOWY. (High-Vacuum Cascade Pump System). Kozlowski, Zbigniew; Sadowski, Marek (Institute of Nuclear Research, Warsaw (Poland)). 1966. 30p. (In Polish). Dep.

Principles of design and construction of a cascade pump system with the final vacuum of 5×10^{-8} torr and a pumping speed 300 l/sec are discussed. A functional diagram and details of the principal components i.e., an oil baffle, a vacuum cold trap, high-vacuum straight-run valves, and a multi-way block valve are described. An applied method of pumping speed measurements and results of exploitation testing are also given. It was established that the high-vacuum cascade pump system is useful for laboratory and industrial activities. (auth)

4679 (N-66-28544) COLD MOLECULAR WELDING STUDY IN ULTRA-HIGH VACUUM. Final Report, October 8, 1964–December 17, 1965. Moeller, C. E.; Bossert, Joe; Noland, M. (Midwest Research Inst., Kansas City, Mo.). Nov. 19, 1965. Contract NAS9-3623. 88p. (NASA-CR-65390). CFSTI $3.00 cy, $0.65 mn.

Cold molecular welding of typical metals which are being used or considered for the Apollo mission was studied and evaluated. The coefficients of friction were determined for various metal combinations under specified conditions. Metal combinations were ranked according to their likelihood of cold welding as indicated by their coefficients of friction. This rating of the 45 metal combinations is based on static breakaway friction after 300 hr of contact and short-time dynamic conditions. In addition to the ultrahigh vacuum tests for 45 metal combinations, the comparative effects of operation in air versus ultrahigh vacuum were determined for four metal combinations. The experimental program consisted of developing test chambers and conducting static and dynamic tests. The test apparatus used three pellets resting or being rotated on an annular wear track. The three pellets were rigidly mounted in a holder and supported a weight; this weight produced a 1,000-psi contact pressure between the pellets and wear surface. The design incorporated heaters for maintaining the wear surfaces at approximately 200°C. The coefficient of friction was determined by measuring the torque necessary to rotate the pellets. The mechanism was enclosed in a stainless steel chamber and evacuated with an oil-free vacuum pumping system capable of maintaining pressures in the 10^{-9} and 10^{-10} torr region. (STAR)

4680 (N-66-32675) CRYOPUMPING-CRYOSORPTION ARRAY SYSTEM FOR A 3-IN. x 3-IN. VACUUM FACILITY. Final Report. (Union Carbide Corp., Tonawanda, N. Y. Linde Div.). May 1966. Contract NAS5-5881. 23p. (NASA-CR-76835). CFSTI $3.00 cy, $0.65 mn.

Test results are summarized for a cryopumping–cryosorption array system. It was established that the overall design and performance was satisfactory and within the required specifications. Ultimate system pressures in the high 10^{-14} to low 10^{-13} torr range were attained during the testing period. Pumping speeds for hydrogen gas exceeded the specified array value based on a 0.16 sticking coefficient for the adsorbent panels. Satisfactory thermal performance was demonstrated while operating a 50-watt heat load inside the test volume. The vacuum integrity of the system with its associated flanges and interface connections was shown by bagged helium mass spectrometer leak tests. The overall cleanliness of the system and the integrity of the bonded sieve panels was successfully demonstrated when no traceable contaminants were found. Performance tables are appended. (auth)

4681 APPARATUS FOR MEASUREMENT OF FRICTION AND ADHESION AT ULTRAHIGH VACUUM. **Brown, R. D.; Burton, R. A. (Southwest Research Inst., San Antonio, Tex.). Rev. Sci. Instrum., 37: 1699-1701 (Dec. 1966).**

An apparatus is described which has been used to measure both friction and adhesion over a wide temperature range (–168 to 538°C) at ultrahigh vacuum (pressures as low as 5×10^{-10} torr). By using sealed reentrant tubes, a number of major gas sources such as electrical wiring and insulation, thermocouples, heaters, and strain gages are eliminated from inside the vacuum chamber. The specimen normal load is introduced through a gimbals-mounted, bellows-sealed arm projecting into the vacuum chamber. For friction experiments, the gimbal ring is oscillated by an external motor and crank, thus causing reciprocating sliding of a pin-type specimen while in contact with a flat specimen. The variations of friction and adhesion with temperature were measured on the apparatus, confirming its effectiveness as a basic instrument. (auth)

4682 ION GAGE FOR VACUUM PRESSURE MEASUREMENTS BELOW 1 x 10^{-10} **Torr. Helmer, J. C.; Hayward, W. H. (Varian Associates, Palo Alto, Calif.). Rev. Sci. Instrum., 37: 1652-4 (Dec. 1966).**

Low pressure measurements by Bayard–Alpert gages are limited by x-ray photoelectric currents at the ion collector, equivalent to a pressure reading of about 1×10^{-11} torr. Through efforts to reduce this x-ray current, the Bayard–Alpert structure has been modified, whereby a beam of ions is extracted from the grid and bent around a corner to a remote collector. By this geometry the collector is shielded from the x-ray source at the grid, and the photoelectric current is reduced by a factor of 100, without incurring a loss in gauge sensitivity. Bending of the ion beam is accomplished by a cylindrical, electrostatic field, in which the ion trajectories are independent of e/m. 100% modulation of the ion beam intensity is achieved by turning off the bending field, thereby permitting pressure measurements as low as 1×10^{-14} torr. A total pressure of 5×10^{-13} torr, nitrogen equivalent, has been measured in a stainless steel vacuum system employing ion sputtering and titanium sublimation as the means of evacuation. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 5071, 5093, and 5679.

4683 (ANL–6968) LINEAR-LOG COUNTING-RATE METER UTILIZING THE TRANSCONDUCTANCE CHARACTERISTICS OF A SILICON PLANAR TRANSISTOR. Eichholz, John J. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Northwestern Univ., Evanston, Ill.

A linear-log counting-rate meter which uses a silicon planar transistor as the log converting element is described. Nine linear ranges include 10-10^5 pulses/sec at full scale with an accuracy of ±1.5% of full scale. Each range can be used with one of six time constants to yield a standard deviation ranging from 1-10%. Log operation covers six decades from 1-10^6 pulses/sec with an accuracy of ±1% of the reading and a time constant corresponding to a standard deviation of 9%. A silicon planar transistor which operates in the zero collector-base voltage mode is used as a feedback element in the operational amplifier to obtain the log response. The logarithmic nature of the curves of emitter-base voltage vs short-circuit collector current of a silicon planar transistor was investigated. The analytical expression for this curve is shown to be $V_{eb} = 2.3\ (kT/q)\ \log\ [(I_c/k) - 1]$. The slope (or volts per collector current decade) of this curve was measured and is found to be 2.3 (kT/q) ± 1% for a collector current range of $10^{-12}-10^{-3}$ A. However, over the collector current decade $10^{-3}-10^{-2}$ A the slope increases and is in error by approximately +40% at a collector current of 10^{-2} A. The unique method of compensating for this error, the advantages of using the silicon planar transistor as a log element, and the design of the counting-rate meter are discussed. (auth)

4684 (BNL–9593) RADIATION MONITORING AND DOSIMETRY WITH INTEGRATING PULSE DISCHARGE IONIZATION CHAMBER DETECTORS. Distenfeld, C.; Bishop, W. (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract AT(30-2)-Gen-16. 18p. (CONF-650616–8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Health Physics Society Annual Meeting, Los Angeles, Calif.

Recently available integrating pulse discharge ionization chambers have been successfully used as detectors for portable dose integrators, environmental area monitors, and for a high energy pulsed accelerator monitoring system. The ion chamber physically consists of a pressure vessel, internally mounted gas discharge tube, anode support structure, and optional plastic inner lining. Chambers are available with either a Freon or Ethylene gas filling of about 10 atmospheres. Gamma sensitivity depends on the filler gas and liner, and is 0.25 and 0.6 mrad for Freon and Ethylene gas respectively. The gamma and neutron energy response characteristics, together with rate dependence effects, were investigated and are discussed. A transistorized, portable, dose integrator, with adjustable alarm level, was developed as an aid in controlling mission exposure to either gamma or mixed field radiation. The device can be set to alarm at any absorbed dose between 0.25 and 600 mrad in increments of 0.25 or 0.6 mrad. Cosmotron area monitoring consists of a sixteen channel system designed to alarm above about 1.2 mrem/hr. In each channel pulses are integrated on two registers, one resettable after appropriate data recording, and the other continuously running. The information presented on the Cosmotron area monitoring system is of an outline nature since the information will be published elsewhere. (auth)

4685 (BNWL-SA–517) NEUTRON SENSITIVE CRITICALITY DETECTOR. Friend, P. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 27, 1966. Contract AT (45-1)-1830. 7p. (CONF-661020–8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A detector is described which is used along with howlers and visual annunciators in a warning system for uncontrolled nuclear criticality accidents. The detector is sensitive only to neutrons instead of to gamma rays which lower the probability of false alarms. (B.G.D.)

4686 (CLOR–47/D) POMIAR STEZENIA ^{222}Rn W POWIETRZU METODA ELEKTROSTATYCZNEGO OSADZANIA JEGO PRODUKTOW ROZPADU. (Measurement of ^{222}Rn Concentration in Air by Means of Electrostatic Precipitation of Its Daughter Products). Wardaszko, R. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 14p. (In Polish). Dep.

The principle and realization of a method of radon-222 measurements in air by means of electrostatic precipitation of its daughter products is described. A 3-liter steel chamber fitted with collecting electrode was used, the latter being simultaneously an alpha radiation detector of suitable geometry. The counting sensitivity of this method was 0.65 counts/Rn-222 disintegration and the detection limit of 4×10^{-14} Ci of Rn-222; it is sufficient to measure radon in atmospheric air without charcoal enrichment of radon. The use of transistorized auxiliary instruments (scaler, HT units) allows the system to be used for field applications. (tr-auth)

4687 (CONF-651015–1) MULTIPLATE SPARK CHAMBER USED AS A FISSION COUNTER. Kamegai, M.; Bernatowicz, H.; Slovacek, R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Oct. 1965. Contract W-31-109-eng-52. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, Chicago, Ill.

Since the intense alpha radiation from fissionable isotopes such as ^{233}U or ^{239}Pu overloads conventional fission chambers, a spark chamber was developed for use as a fission counter. (B.G.D.)

4688 (MIT-2098-276) LARGE TRANSMISSION, MAGNETIC, HEAVY-PARTICLE SPECTROMETER WITH GOOD RESOLVING POWER. Smith, Donald L.; Enge, Harald A. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Oct. 1966. Contract AT(30-1)-2098. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method for adapting a broad-range magnet for large solid angle, high-resolution spectrometry is described. The instrument uses a preceding magnetic quadrupole lens to increase the collecting power of the instrument. The median plane of the magnet is normal to the reaction plane. Correction for Doppler broadening is obtained, to first order, by rotating the quadrupole lens about its axis. The instrument is first adjusted to yield a stigmatic image of a monochromatic source at the detector slits. When there is Doppler broadening, the quadrupole lens is rotated yielding an astigmatic image of the source. A point source focuses to a narrow line. This is an advantage because then the large transverse magnification does not affect the sharpness of the line (resolving power) but only its length. (B.G.D.)

4689 (NP–16394) SISTEMA DLYA SVERKHSKOROSTNOI REGISTRATSII KONTUROV SPEKTRAL'NYKH LINII. (System for Ultrafast Registration of Spectral Line Shapes). Kruglyakov, E. P.; Nesterikhin, Yu. E. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 14p. (In Russian). Dep. mn.

The characteristics of a modernized double converter spectrometer for ultrafast registration of spectral line shapes are described. (TSS)

4690 (ORO–3349-2) A SYSTEM FOR MEASURING FAST SCINTILLATION DECAY TIMES. Fannin, David Ronald (Florida State Univ., Tallahassee). Aug. 1966. Contract AT(40-1)-3349. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The considerations involved in the design, construction, and the calibration of a system for measuring fast scintillation decay times are described. Results of measurements on several scintillators are reported. Excitation was primarily by means of α particles. (B.G.D.)

4691 (UCID–5168) MICROWAVE SPECTROMETER AND ITS RESEARCH APPLICATIONS. Ernst, Klaus; Anderson, Roger (California Univ., Livermore. Lawrence Radiation Lab.). June 16, 1966. Contract W-7405-eng-48. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information concerning the capabilities of a recently completed microwave spectrometer are presented. After a brief description of the instrument and its performance, the use of microwave spectroscopy in chemistry research and research in chemical kinetics is outlined. (B.G.D.)

4692 (UCRL–3307(Rev.3)) LAWRENCE RADIATION LABORATORY COUNTING HANDBOOK. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1, 1966. Contract W-7405-eng-48. 126p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A compilation of operational techniques and performance specifications on counting equipment in use at Lawrence Radiation Laboratory is presented. Topics included are amplifiers, cables and coaxial components, coincidence systems and discriminators, components for amplitude analysis, definitions and standards, electronic circuits for spark chambers, oscilloscopes and monitoring, photomultipliers and scintillators, scalers and readout equipment, and waveform generators and power supplies. (B.G.D.)

4693 (UR-875-167) PROGRAM AND INTERFACING FOR "ON-LINE" USE OF A PDP-1 COMPUTER FOR BUBBLE CHAMBER FILM ANALYSIS. Metzger, W.; Melissinos, A. C.; Berlinghieri, J.; Phelps, S. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Aug. 1966. Contract AT(30-1)-875. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The present operation of a PDP-1 computer on-line to two Vanguard measuring machines used to process bubble chamber film is discussed. The input/output hardware, the main program (EXPENSIVE 526), and the subroutines are described. (B.G.D.)

4694 RANGE-MOMENTUM RELATIONSHIPS FOR HEAVY LOW-VELOCITY IONS. Lou, A. (Univ. of California, Los Angeles); Sandes, L. R.; Prowse, D. J. Nuovo Cimento (10), 45B: 214-25(Oct. 11, 1966).

The range-momentum relations for heavy low-velocity ions were determined by measuring the ranges of nuclear emulsion nuclei which were scattered elastically by artificially accelerated 400-MeV ^{40}Ar and 200-MeV ^{20}Ne ions. The measurements were made in both K-5 and K-2 nuclear emulsions. Assuming the energy-loss process to be the same for all ions, these observations were used to construct a universal range-momentum relation for ions of all charge states. (auth)

4695 THE GAMMA COUNTING EFFICIENCY OF $4\pi\beta$ GAS COUNTERS. Urquhart, D. F. (Australian Atomic Energy Commission, Lucas Heights). Int. J. Appl. Radiat. Isotopes, 17: 609-14(Dec. 1966).

To obtain the true β-count for sources emitting both β and γ radiation in a $4\pi\beta$ gas counter it is necessary to make a correction for counts produced by γ interactions with the counter walls, the counter gas, the source mount foils and the source itself. An improved experimental method for measuring these effects is reported and data presented which enable estimates to be made of the γ-counting efficiency of typical $4\pi\beta$ counters. (auth)

4696 METHANE FLOW METER WITH VARIABLE SENSITIVE AREA. Erbe, H. (Telefunken AG, Ulm, Ger.). Atompraxis, 12: 445-50(Sept. 1966). (In German).

In measuring weak radioactive samples, time is wasted determining the background of the meter. Time can be saved by adapting the detector to the size of the sample. To avoid interchanging the meters in a low-level arrangement a methane flow meter was built, the efficiency of which may be varied simply by exchanging two cable connections. The effective diameter is either 6 cm or 2.2 cm with a background of 2 cpm or 0.52 cpm respectively. Some examples are given which show how measured time varies if measuring range is changed. (tr-auth)

4697 STANDARDIZATION OF THE QUENCHING EFFECT IN LIQUID SCINTILLATION SYSTEMS. Schwab, R. F. (Firma Tracerlab, Cologne). Atompraxis, 12: 450-4(Sept. 1966). (In German).

The difficulty with all measurements of radioactivity lies in determining the exact count yield. All the various principles of demonstration have characteristics which diminish the count yield. In the liquid-scintillation technique, all these characteristics are summarized as the "quenching effect." During twelve years of experience with this technique, various standardization procedures have been established for exact determination of this effect, which can vary from sample to sample. The advantages and drawbacks of individual methods are summarized and the present state of the technique described. (tr-auth)

4698 A MEASURING UNIT FOR THE CONTINUOUS DETERMINATION OF THE ^{14}C-ACTIVITY AND THE CO_2-CONCENTRATION WITH LARGE-SURFACE METHANE FLOW METERS. Gebauer, H.; Suttor, F. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Atompraxis, 12: 454-7(Sept. 1966). (In German).

A continuously operating $^{14}CO_2$ exhalation measuring unit for metabolism studies in the human and veterinary medicine as well as for biological research is described. Contrary to equipment known up to now which operate by means of ionization chambers, this device uses large-surface methane flow counters in a differential circuit. The advantages offered by this system are: increased sensitivity measurement, reliability of operation as well as short time recording constants. (tr-auth)

4699 DETERMINATION OF THE COMPOSITION OF NATURAL AEROSOL ACTIVITY WITH CONTINUOUS FILTER-TAPE INSTRUMENTS. Vogt, K. J. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 12: 457-61(Sept. 1966). (In German).

Filter-tape instruments for continuous measurement of aerosol activity, with delayed measurement relative to the extraction of samples are described. A corrective factor is derived for calculating aerosol activity from filter activity including the radioactive decay on the filters during and after dust collection. If the aerosol activity consists of several components with various half-life values, the mixture can be analyzed by using a corresponding number of detectors. As an example, the natural aerosol activity from products deriving from Rn and Tn is measured continuously and examined with regard to composition. The measurement results are discussed. (tr-auth)

4700 CONSTRUCTION AND USES OF A RADIOLOGICAI MEASURING VEHICLE. Franke, Th.; Heigwer, G.; Keil, R.; Rajewsky, B. (Max Planck-Institut fuer Biophysik, Frankfurt am Main). Atompraxis, 12: 461-5(Sept. 1966). (In German).

The construction of a vehicle for radiological measurements is described; it is especially intended for determining the radiation effects of radioactive nuclides naturally present in the soil, as well as for determining deposits of artificial radioactivity. It is shown that with the use of gamma spectrograms obtained with a NaI(Tl) scintillation crystal, it is possible to determine separately the radiation dose output of the ambient radiation and the radiation from fallout deposits. (tr-auth)

4701 A Ge(Li) GAMMA SPECTROMETER FOR (n,n'γ) MEASUREMENTS. Williams, G. H.; Morgan, I. L. (Texas Nuclear Corp., Austin). Contract AT(40-1)-2791. Nucl. Instrum. Methods, 45: 313-18(1966). (ORO-2791-22).

A Ge(Li) spectrometer system is described which was developed to observe de-excitation gamma rays caused by inelastic scattering of fast neutrons. The system consists of a 13 cm^3 Ge(Li) detector operating in anticoincidence with a NaI(Tl) annulus. Time-of-flight gating is used to reduce neutron induced background in the Ge(Li) detector, and is accomplished by nanosecond pulsing of a 3.2 MeV Van de Graaff. (auth)

4702 DEUTERATED ORGANIC CRYSTALS FOR SCINTILLATION SPECTROMETRY OF FAST NEUTRONS. Belikova, G. S.; Belyaev, L. M.; Benetskii, B. A. (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Cryst. (Engl. Transl.), 11: 387-9 (Nov.-Dec. 1966).

Translated from Kristallografiya, 11: 439-42(May-June 1966).

The characteristics of mixed single crystals of octadeuteronaphthalene, containing 81.7 and 94.3 at % deuterium, were studied. Mixtures were made by melting the single crystals with 0.7 wt % anthranilic acid—the optimum content for naphthalene scintillation. The isotope interchange between the molecules of anthranilic acid and octadeuteronaphthalene was indicated by luminescence spectra and scintillation spectrometry. Luminescence spectra of pure and mixed crystals were obtained using a mercury lamp with a filter (λ = 313 mμ). The spectra were different from naphthalene due to an isotopic increase in levels resulting from the substitution of hydrogen by deuterium. The scintillating properties were measured by the secondary frequency spectra of γ-quanta after bombardment by 14-Mev neutrons. Mixed naphthalene was compared with mixed octadeuteronaphthalene by this method. Maxima were observed in the spectra of octadeuteronaphthalene crystals at a channel number of 25, as a result of the neutron energy. These crystals could serve as a new class of organic scintillators for neutron spectrometers in the megavolt region. Such crystals could be produced industrially in diameters of 200 mm from which various scintillator shapes can be fashioned. Other favorable aspects of these crystals such as light yield and inelastic dispersion by fast neutrons were discussed. (ATD)

4703 SIMPLE ANTICOINCIDENCE DEVICE. Kadecka, Vincenc (Krajska Hygienicko-Epidemiologicka Stanice, Prague). Jad. Energ., 12: 460-1(1966). (In Czech).

The use of special counting tubes leads to a considerable volume and weight reduction of anticoincidence devices. In the electronic part an especial patented circuit is used simplifying the whole equipment. The background of 0.8 imp/min may be considered as an excellent result with respect to small weight and simple circuit connection. The device with its properties supersedes much greater and more complicated instruments. (auth)

4704 ENERGY ALIGNMENT OF GAMMA SPECTROMETERS. Coats, G. I.; Goldin, A. S. (Public Health Service, Winchester, Mass.). Public Health Rep. (U. S.), 81: 999-1007 (Nov. 1966).

Procedures are recommended for the energy alignment of gamma spectrometers. Topics discussed with respect to spectrometer calibrations of thallium-activated sodium iodide crystals connected to multichannel analyzers are energy calibration curve, channel alignment, linearity, source geometry, gain and baseline shifts, and drift characteristics. (B.G.D.)

4705 MODE OF OPERATION, DESIGN, AND PROPERTIES OF AN IONIZATION-CHAMBER FLUE-GAS INDICATOR USING

^{85}Kr SOURCES. Schulze, H. W.; Bothe, H.-K.; Nenoff, N. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Isotopenpraxis, 2: 381-5(Oct. 1966). (In German).

Measurements were made on the decrease of ionization current by flue gas of a defined kind and amount in an ionization chamber. An ionization-chamber flue-gas indicator is described, which can be used without any provisions for radiation protection. The mode of operation and the effect of vapors, aerosols, fog, or powder on the operation of this indicator are discussed. (auth)

4706 USE OF SI-5G COUNTERS IN THE SUB-GEIGER REGION. Kapustin, I. N.; Zhavkov, V. A. (Polar Geophysical Inst., Kola Branch, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 329-30(1966).

Translated from Geomagn. Aeronomiya, 6: 411-12(1966).

Dead time and count characteristics were observed in the sub-Geiger region to find a way of working with counters at lowered voltages. The count characteristics of the SI-5G counter are shown. The relationship between the increase in the extent of the plateau and circuit sensitivity is given for slopes of the count characteristic of 0.025%/V and 0.5%/V. The data suggest that it is possible to use S1-5G counters in the proportional region in meson telescopes of large area, where the first requirement is high detector reliability. (J.H.M.)

4707 NEW-TYPE ENERGY SPECTROMETER FOR MEDIUM-FAST NEUTRONS. Dobrozemsky, R.; Felber, H. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 173: 331-42 (1965). (In German).

A method is given which makes it possible to determine the spectrum of medium-fast neutrons in the energy range of 50 to 100 keV in the presence of fast neutrons of any incident direction and gamma radiation. The proportional counter tube is provided with a 4π-anticoincidence arrangement, which limits the central counter volume all around. With this arrangement it is possible, in combination with the method of optimal pressure regulation, to reduce the wall effects. An examination of the method is given on the spectrum of a Pu–Be neutron source. (L.B.S.)

4708 EXPERIMENTAL STUDIES OF THE NATURAL RESOLUTION OF MONOCRYSTALLINE SCINTILLATION NaI(Tl) AND CsI(Tl) SCREENS IN BETATRON GAMMA RADIATION. Gromov, Yu. V.; Yakobson, A. M. Defektoskopiya, No. 4, 87-90(1966). (In Russian).

Experimental data are given on the geometric resolution of monocrystalline scintillation screens made of 3- to 30-mm-thick NaI(Tl) and CsI(Tl) crystals with mirror and black finishes operating with a 6- to 17-MeV γ-betatron. (tr-auth)

4709 LEAK-PROOF ARGON IONIZATION DETECTOR CELL. Wharton, D. R. A.; Bazinet, M.; Wharton, Martha L. (Army Natick Labs., Mass.). J. Gas Chromatog., 4: 353-4(Sept. 1966).

In the argon ionization detector, an electrically insulated system at joints that are leak-proof and nonadsorptive is required. In some designs it is necessary to remove the anode to tighten the connection and seal the collar. This not only takes time but exposes the operator to appreciable amounts of ionizing radiation. An effective leak-proof cell that may be maintained conveniently with a minimum amount of attention was developed. The body of the standard cell was retained, while the anode and the means of sealing the cell were changed. Teflon washers are provided to give an electrically insulated anode as well as a leak-proof seal at the collar. To connect the gas line into and out of the detector, an improved connector was designed, which is easily detachable, leak-proof, nonporous, and no larger than the flow-line, so as to preclude turbulence and mixing of the effluents. It consists of two lengths of Kovar metal tubing joined together by glass tubing of the same bore. The use of the described devices in the detector system was satisfactory and entailed a minimum of attention. (BBB)

4710 SEMICONDUCTOR RADIATION DETECTOR. Svelto, V. (Laboratori CISE, Milan). Nuovo Cimento (1), 3: Suppl., 598-612 (1965). (In Italian).

The development of semiconductor detectors in the past 5 years is briefly reviewed. Junction detectors, equivalent circuits of junction detectors, measurement of the rise time and resolution time, errors in the energy measurement, channel effect, energy to generate an electron-hole pair, and detectors with Li ions and their energy resolution are considered. (J.S.R.)

4711 STUDIES WITH A SCINTILLATION COUNTER FOR DETECTION OF EXOELECTRONS. Hempel, Max; Kochendoerfer, Albert; Tietze, Alfons (Max-Planck-Institut fuer Eisenforschung, Dusseldorf). Arch. Eisenhuettenw., 37: 353-5(Apr. 1966).

Equipment is presented and described, consisting of a scintillation counter, stabilized photomultiplier, and low temperature, high-vacuum system designed for measurement of exoelectrons with energies as low as 1 keV. The scintillators used included an anthracene crystal and a plastic phosphor. Comparison of curves from measurements of ^{14}C and ^{3}H sources showed that the system should be capable of measuring exoelectrons of 18 keV, so that these "monochromatic" electrons should have a higher probability of measurement than the "polychromatic" β particles of a ^{3}H preparation. The null effect was not independent of the applied acceleration voltage, as was expected at first, but rose sharply when it reached 6 keV. The beginning of the rise was almost independent of the anode-cathode separation, and appeared at almost the same voltage with each of the two crystals, using a vacuum of the order of 10^{-5} torr. When Al foils were interposed between the scintillator and wire grid the rise did not appear until 20 keV, and with a brass shield glow discharges appeared at higher voltages. It is probable that the relation between the null effect and the acceleration voltage was due to the effects of electrons emitted from the cathode through a relatively weak electrical field. Since the field emission is related to the field strength and the time, this equipment could not be used for detection of exoelectrons from shaped metal surfaces. (BBB)

4712 MODIFIED DETECTION ARRANGEMENT FOR SCANNING ELECTRON DIFFRACTION INSTRUMENT. Dove, D. B.; Denbigh, P. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instrum., 37: 1687-9(Dec. 1966).

Modifications to the detection arrangement of a scanning electron diffraction apparatus, described by Grigson (Rev. Sci. Instr., 36: 1587(1965)), have been carried out to (i) permit rejection of inelastically scattered electrons, (ii) provide measurements of the main beam by Faraday cage, and (iii) provide high sensitivity measurements using a semiconductor detector and modulated beam. (auth)

4713 SHUNT TRIGGERED FLASHTUBE ILLUMINATION SYSTEM DESIGN. Sondericker, J. H. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 37: 1705-7(Dec. 1966). (BNL-10391).

The advantages and design flexibility gained by use of the shunt trigger method are discussed. A typical circuit is described which is used to turn on a series ignitron and simultaneously ionize the xenon flashtube. The trigger pulse has an amplitude of 30 kV with a peak current of 100 A. Its rate of rise with a flashtube load is better than 40 kV/μsec with a half width of less than 1 μsec. (auth)

4714 SCATTERING CHAMBER FOR STUDY OF THREE-BODY REACTIONS. Ehlers, D. H.; Knowles, H. B.; Pecka, D. C.; Wise, M. N. (Washington State Univ., Pullman). Rev. Sci. Instrum., 37: 1708-10(Dec. 1966).

A mechanically simple scattering chamber for heavy particle angular correlation studies was designed and constructed. The chamber has provisions for controlling the motion of each of two solid state detectors. The lower detector possesses one degree of angular freedom in the horizontal plane, while the upper detector has two degrees of angular freedom and can be scanned continuously over the upper hemispherical surface. By means of external controls, the target can be tilted as well as rotated in order to accommodate to detector position. (auth)

Radiation Dosimeters

Refer also to abstracts 4554, 4563, and 4684.

4715 PROPERTIES AND PREPARATION OF POLYCRYSTALLINE LiF PHOSPHORS USED IN THERMOLUMINESCENT DOSIMETRY. Frank, M.; Edelmann, B. U. (Technische Univ., Dresden). Kernenergie, 9: 228-32(July 1966). (In German).

A preparation technique of a LiF phosphor with a glow maximum of thermoluminescence at 200°C is described. Measurement of doses accumulated for one month or even for some longer time may be carried out by using this phosphor in the dose range of 1 to about 10,000 R. The following properties of the phosphors are discussed: sensitivity to radiation, energy storage, effects of repeated exposure, and annealing. The effect of high radiation doses on the thermoluminescence of the phosphor was studied. (auth)

Radiometric Instruments

4716 (TID-23368) PORTABLE RADIOACTIVE ISOTOPE SNOW GAGES FOR PROFILING SNOWPACKS. Smith, James L.; Willen, Donald W.; Owens, Michael S. (Forest Service, Berkeley, Calif. Pacific Southwest Forest and Range Experiment Station). Feb. 10, 1966. Contract AT(49-11)-2088. 53p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Portable, battery-operated neutron and gamma scatter gages and gamma transmission gages have been tested for their ability to profile snowpacks. Gamma transmission is shown to be the most practical method for measuring snow density. With a gamma system using a scintillation detector and pulse height analyzer, snowpacks may be profiled in one-half inch increments at a rate of 1 foot of snowpack per minute. Temperature problems and methods of control of snowmelt around access tubes are presented. Data are provided which shows this system is adaptable as a high elevation, remotely operated, telemetered snow gage which may be used to monitor snow accumulation, snow metamorphosis, and snowmelt. And it may be used as a high elevation flood warning device. A primitive uncollimated gamma transmission system may be used to profile snow density and obtain accuracies of ±2.6 percent of actual snow density. A collimated gamma transmission system, in conjunction with a Geiger–Mueller detector, was used to profile a snowpack in 2-inch increments. Both neutron and gamma scatter gages are shown to estimate snow density to within ±2 percent of gravimetrically determined density. Several calibration curves are needed for each to compensate for effects near the soil–snow and air–snow interfaces. The neutron gage may be used to locate ice lenses. (auth)

4717 (AEC-tr-6699) CATALOG OF THE INSTRUMENTS USING NUCLEAR SOURCES AND UTILIZED FOR CONTROLLING AND AUTOMATION OF TECHNICAL PROCESSES, PRODUCED BY THE ALL-UNION GROUP "ISOTOPE," 1965. Translation of Ktalog Pribory, Deistve Kotorykh Osnovano na Ispol'zovanii Istochnikov Yadernykh Izluchenii, dlya Kontrolya i Avtomatizatsii Tekhnologicheskikh Protsessov, Postavlyaemye Vsesoyuznym Obbedineniem "Izotop" v 1965, Atomizdat, Moscow, 1965. 59p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The design and performance of 58 radioisotope devices for the control and automation of technical processes are given. These instruments include relay-type devices, level, thickness, and density gages, industrial defectoscopic devices, and others. Radioisotope devices in the developmental stage are also discussed. (J.F.P.)

4718 CONTINUOUS RADIOMETRIC MEASUREMENT OF THE DENSITY AND MOISTURE OF CERAMIC PRODUCTS. Holzhey, J.; Schwarzlose, J. (Forschungsinstitut fuer NE-Metalle, Freiberg i. B.). Isotopenpraxis, 2: 387-90(Oct. 1966). (In German).

In producing ceramic materials the moisture of the raw product must be kept as constant as possible. The usually continuous production process calls for a sufficiently rapid moisture measuring method. Since there is a direct connection between moisture and density of ceramic intermediate products, moisture control by density measurement suggests itself (moisture determination by means of neutrons being unsuitable for various reasons). A measuring arrangement and the results obtained in the application of a weight per unit area gage, VA-T-70A, are discussed. (auth)

4719 DETERMINATION OF SEDIMENT DENSITY BY GAMMA ATTENUATION. McHenry, J. Roger (Dept. of Agriculture, Oxford, Miss.). U. S. Dept. Agr. ARS 41-61: 16p(Oct. 1962).

Theoretical aspects and mathematical bases of the use of γ radiation attenuation for estimation of density of materials are presented. The measurement of density as a function of the attenuation of a radioactive emission is evaluated as a means of determining sediment density and concentration in silt boxes, laboratory flumes, and flowing streams. The transmission method, that is, the measurement of the attenuated primary emission, shows considerable promise on the basis of laboratory investigations. Data obtained with a ^{137}Cs source indicated excellent agreement between experimental results and theoretical values when such monoenergetic γ rays were measured. The differential spectrometer provided an excellent means for such measurements. Plans for field studies with a two-probe system incorporating a pulse height analyzer are explained. An appendix provides a mathematical derivation of formulas used in the theoretical analysis of this concept. (BBB)

4720 ISOTOPE FLAW DETECTORS FOR INVESTIGATING WELDED PIPE SEAMS AND BOILER ELEMENTS. Kosteski, Stanislav. 4p. (In Russian). (CONF-641024-14). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

Descriptions are given of six isotope flow detectors: a 10 Ci ^{192}Ir source detector mounted on a carrier and inserted into a pipe for checking welded seams; a detector operating with a ^{137}Cs source and mounted into a holder capable of reaching less accessible points; a detector with a ^{192}Ir source activity of 5g equiv Ra placed in a mercury filled lead casing used for examining the periphery of pipe seams; a detector with ^{192}Ir activity of 2g equiv Ra used for a corkscrew method of pipe examination; a 10 Ci ^{192}Ir source detector contained in a 75 mm lead container used for examining less accessible places; and the alligator, a 2 × 2 mm detector with 8.5 Ci ^{60}Co source designed for checking thick-wall pipe seams. (TTT)

4721 PERFORMANCE OF INSTRUMENTATION FOR NUCLEAR TECHNIQUES IN MEASUREMENT, CONTROL, AND AUTOMATION MADE BY THE DRESDEN VACUTRON VIB PLANT. Khaimann, R. 21p. (In Russian). (CONF-641024-1). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

Stationary and movable thickness gages, which are widely used in plastics fabricating plants and in aluminum- and paper-rolling mills, contain ^{85}Kr, ^{204}Tl, or ^{90}Sr sources. An automatic thickness gage has operated for 3 years in a cable factory on resins of 0.3 to 1.2 mm thickness with a precision of ±0.02 mm. A cord-rolling operation is monitored with a beta back-scattering gage. A densitometer using 320 μCi of ^{137}Cs determines the solids content of a suspension of fat by measuring the gamma absorption. Another gage is made which can regulate the density of the tobacco in cigarettes. Gamma-source equipment is made for controlling the electric conveyors in mines and for making the red signals at danger spots, and coke carriers, for example, have been successfully lined up with such equipment for 4 years. A gamma gage has been used for close control of the level in a heated vessel whose contents are mixed by a stirrer operating at 20 rpm and for regulating the feed. Productivity was increased when a gamma gage was used to change the slope of a conveyor-belt system several kilometers long. A ^{60}Co gage is made for measurements inside a thick-walled concrete structure, e.g., a generator enclosure. A source mounted inside a tube serves as a probe for measuring levels inside pressurized vessels in large electric-power stations. (TTT)

4722 MOISTURE MEASUREMENT UNDER FIELD AND INDUSTRIAL CONDITIONS WITH NEUTRON GAGES. 8p. (In Russian). (CONF-641024-3). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

The slowing down of fast neutrons by hydrogen atoms is proportional to the amount of hydrogen, and thus of water, present and may be used for nondestructive determination of hydrogen or water. The neutron source should give a high neutron yield and a small gamma output and should have a long half life, for example americium–beryllium and plutonium–beryllium. The detector should have a high sensitivity, temperature stability, compactness, and ruggedness. Two moisture gages are described, and examples of uses are given, for example, for determining moisture in sand to improve the quality of concrete or glass made from it; moisture in lime or fertilizer on a conveyor belt to ensure product quality; and hydrogen concentrations to find the density of a silicate foam or the amount of a hydrocarbon present. (TTT)

4723 SPECIAL CONSIDERATIONS OF THE EQUIPMENT SET-UP FOR BACK-SCATTER MEASUREMENTS USING A SINGLE-CHANNEL PULSE ANALYZER. Kuntse, G.; Leiteritz, F. (Inst. of Applied Radioactivity, Leipzig). 14p. (In Russian). (CONF-641024-8). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

The effect of the channel width (1, 2, and 5 V) and position on its sensitivity in measuring gamma back-scattering for use in thickness determinations was studied. With a NaI crystal scintillator the sensitivity depended on the channel position: The back-scatter intensity was decreased 40 to 50% when the channel was displaced 5 V regardless of the channel width. With a CsI crystal scintillator, the intensity was decreased only 10% under similar conditions. The possible reasons for differences in the ^{137}Cs spectra made with the two crystals are discussed, and a set-up is described which measures a 2-mm thickness of iron to ±0.1 mm. This consists of a data unit, analyzer with control lamps, and a pulse rate counter. It is easily constructed as a portable, battery-operated, unit. A channel width of 4 V was considered optimum, and the initial pulse amplitude was so selected that the back-scatter peak was at 4 V. (TTT)

Miscellaneous Instruments and Components

Refer also to abstracts 4681, 5132, 5213, 5608, and 5708.

4724 (ANL-7243) AN IMPROVED CRYOGENIC LIQUID-LEVEL SENSOR. Hyman, L. G.; Sheppard, J. F.; Spinka, H. (Argonne National Lab., Ill.). July 1966. Contract W-31-109-eng-38. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A new liquid-level indicator, consisting of a diode heated by a resistor, is described. The effects of diode current, resistor power, heater pulse duration, and pressure are discussed. (auth)

4725 (CLOR-52/D) TEMPERATURE DEPENDENCE OF FET AMPLIFIERS USED WITH JUNCTION DETECTORS. Katkiewicz, W. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1966. 8p. Dep.

The energy resolution of the FET input stages of amplifiers used in conjunction with junction detectors was investigated in the temperature range +30 to −70°C. For 2N2500 and 2N3277 input stages the increase in resolution was about 0.5% C^{-1} with decreasing temperature. This was the result of a drop in the thermal channel noise as well as increase of FET transconductance g_m. (auth)

4726 (IS–1477) WIDE LINE NMR INDUCTION AND BRIDGE SPECTROMETER FOR THE FREQUENCY RANGE 2 TO 90 MHz. Torgeson, D. R. (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A wide-band, variable-frequency nuclear magnetic resonance spectrometer is described for use with either a crossed-coil induction probe in the frequency range 2 to 40 MHz or a parallel "T" rf bridge from 2 to 90 MHz. A novel use of simple rf circuits is described wherein the receiver amplifier has useful gain to 95 MHz and the transmitter amplifier has useful gain to 45 MHz. A simple modification of the Varian Associates 8-16 MHz induction probe for use with this circuit to 40 MHz is described. Sensitivity of the instrument with both the probe and bridge compares most favorably with a commercial induction spectrometer. A broad-band crystal oscillator for use with this spectrometer in the frequency range 2 to 44 MHz is presented. All the circuits are esentially free of microphonic noise. (auth)

4727 (KAPL-M–6575) DYNO-1: A PROGRAM TO COMPUTE THE DISTRIBUTION OF SECONDARY ELECTRONS IN PHOTOMULTIPLIERS. Edwards, J. E.; McCarthy, J. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 21, 1966. Contract W-31-109-eng-52. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

DYNO-1 is a FORTRAN program for calculating the distribution of electrons that are emitted from a photo-multiplier composed of a series of dynodes. The output from each dynode is assumed to have a Polya distribution. (B.G.D.)

4728 (LA-DC–7988) INTENSITY MODULATION EFFECTS IN MULTIPARAMETER DISPLAYS. Steger, William W. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 10p. (CONF-661020–12). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A number of photographs of simulated multiparameter displays are presented, showing the visual effects of several different matrix spot intensity modulation techniques. It is shown that brightening the matrix spots in direct proportion to contents, or height contributes to the 3-dimensional illusion of isometric displays. It is also shown that brightening the matrix spots in approximate logarithmic, rather than linear proportion to contents provides improved highlighting of small picture detail, and prevents washout of picture under high ambient light viewing conditions. Conclusions are also drawn concerning the necessary CRT spot resolution for acceptable data picture quality, and minimum frame rate for flicker-free viewing. (auth)

4729 (NYO–3421-9) AFTERPULSES IN PHOTOMULTIPLIERS. Morton, G. A.; Smith, H. M.; Wasserman, R. (Radio Corp. of America, Princeton, N. J. RCA Labs.). Oct. 1966. Contract AT(30-1)-3421. 18p. (CONF-661020–11). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

Recently afterpulses were found in experimental photomultipliers being used in dark pulse studies. Because the phenomenon offers possible clues to some of the mechanisms in producing certain types of dark pulses, it was investigated, and the results are reported. (B.G.D.)

4730 (ORNL-P–2639) NEW APPROACH TO DIRECT CURRENT INTEGRATION. Glass, F. M.; Courtney, C. C.; Kennedy, E. J.; Wilson, H. N. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 10p. (CONF-661020–7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 13th Annual Nuclear Science Symposium, Boston, Mass.

A new all-solid state direct-current integrator integrates currents as low as 10^{-11} ampere with an accuracy of 1%. The operating principle is similar to that of more conventional current integrators in that the voltage across a storage capacitor in the input circuit is monitored by an electrometer type operational amplifier, the output of which triggers a discriminator at a given voltage level. The discriminator generates a reset pulse which removes a fixed charge from the integrating capacitor. This is where the similarity ends. The diode pump circuit, which has long been recognized as an ideal circuit for removing precise quantities of charge from the integrating capacitor, has been replaced by complementary silicon planar transistors that operate in the inverted-mode and serve as current switches. These transistors normally have both their base-emitter and base-collector junctions reverse biased and look like open switches with leakage currents of about 10^{-13} ampere. Reset pulses switch these transistors from the reverse-biased state to the active state for a precise time during which a constant current flows to or from the integrating capacitor. Therefore, each reset pulse removes from the integrating capacitor a precise charge that is the product of the current and the period of the active state. By the employment of sufficient gain in the operational amplifier to maintain small voltage excursions at the input, the total effective leakage may be kept as low as 10^{-14} ampere. A scaler output provides an indication of the integrated charge, and a built-in duty cycle meter calibrated in counts per second provides an indication of the instantaneous current. (auth)

4731 (RT-EL–(66)6) INTRODUZIONE ALLO STUDIO DEGLI ELEMENTI A SOGLIA ADATTIVI. (Introduction to Investigation Adaptive Logic Elements). Arabia, M.; Colussi, S.; Pallottino, G. V.; Sano, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 26p. (In Italian). Dep. mn.

The working principles of adaptive logic systems are described in view of their applications in nuclear instrumentation and nuclear process control. The basic problems are stated which are pertinent to the synthesis of adaptive logic networks and their practical realization. With regard to that a comparison is made among the various adaptive components already existing and a new one which is under study. (auth)

4732 (RT-EL–(66)-7) SAMO: SISTEMA A MODULI OPERATIVI PER L'AUTOMATIZZAZIONE DI ESPERIENZE DI FISICA NUCLEARE. (SAMO: Operative Modules Automation System for Nuclear Physics Experiments). Bevilacqua, S.; de Agostino, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 18p. (In Italian). Dep. mn.

The "Operative Modules Automation System" SAMO is presented. The system is designed to automatize the various types of nuclear physics experiments in a standard way. The system was used in some automatic equipment and is actually employed in new projects. (auth)

4733 NEAR 100 PERCENT EFFICIENCY ION DETECTOR FOR USE WITH QUADRUPOLE MASS FILTER. Marchand, P.; Paquet, C.; Marmet, P. (Univ. Laval, Quebec). Rev. Sci. Instrum., 37: 1702-4(Dec. 1966).

A 14-stage Ag−Mg Allen-type electron multiplier is used as an ion detector with a large exit aperture (5 cm dia) quadrupole mass filter. A simple lens system provides sufficient focusing on the first dynode of the multiplier to insure near 100% ion collection and extremely stable detection. A pulse-height distribution for single ion impacts closely similar to that expected using Poisson statistics is obtained. Arguments as to the system's efficiency as well as details of the construction of the multiplier are given. (auth)

4734 SIMPLE MECHANICAL LIGHT DISCRIMINATOR FOR RECORDING OF LUMINESCENCE. Peled, S.; El-Hanany, U.; Yatsiv, S. (Hebrew Univ. of Jerusalem). Rev. Sci. Instrum., 37: 1649(Dec. 1966).

A mechanical device for obtaining fluorescence spectra is described. The elimination of the exciting radiation and stray light in this device is highly effective, so that very weak fluorescence signals can be recorded without optical filters. (auth)

4735 SPECTRAL RESPONSE SYSTEM FOR PROCESSING PHOTOCATHODES. Ioannou, John T.; Theodorou, Dimitri G. (Bendix Corp., Southfield, Mich.). Rev. Sci. Instrum., 37: 1677-81(Dec. 1966).

A processing system for photocathodes was developed whereby the variation of the spectral response of the photocathode can be continuously monitored throughout processing. The design details of the system are given together with some examples which show the variation of the spectral response of an S-20 photocathode during various steps in processing. This system should lead to procedures for controlling the luminous sensitivity in any portion of the visible spectrum, better predictable photocathode-to-photocathode uniformity, and reduced processing time. (auth)

4736 RELIABLE, INEXPENSIVE, TRANSISTORIZED LIQUID NITROGEN LEVEL CONTROLLER. Seguin, H.; Leonard, R. W.; Imae, J. (Univ. of California, Los Angeles). Rev. Sci. Instrum., 37: 1747(Dec. 1966).

A self contained liquid nitrogen level controller having positive switching action without jitter was designed and constructed utilizing a transistorized Schmitt trigger as the switching element. (B.G.D.)

4737 SIMPLE, INEXPENSIVE, TRANSISTORIZED, CONTINUOUSLY MONITORING LIQUID HELIUM AND LIQUID NITROGEN LEVEL INDICATOR. Seguin, H. J.; Leonard, R. W. (Univ. of California, Los Angeles). Rev. Sci. Instrum., 37: 1743-5 (Dec. 1966).

A level indicator for continuous monitoring of liquid helium and liquid nitrogen is described, which consists of a rigid open circuited coaxial line, hermetically sealed at the top end and running down to the bottom of the Dewar, the principle of operation being therefore to measure the relative change in the electric capacitance of the coaxial line which varies in accordance with the liquid level in the cryostat. (B.G.D.)

4738 AUTOMATIC TEMPERATURE CONTROLLER FOR LOW TEMPERATURE ADIABATIC CALORIMETER. Gayle, T. M.; Berg, W. T. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum., 37: 1740-2(Dec. 1966). (ORNL-P-2321).

An electronic control system for an adiabatic calorimeter is described, whose major components are commercially available, that is capable of temperature control to ±0.001° in the temperature range 2 to 20°K. Other characteristics are that the maximum power required is 1 or 2 W and the thermal lag of the system is small (B.G.D.)

4739 MULTIPURPOSE COLLIMATING SYSTEM. Chaudhri, M. Anwar (Cambridge Univ., Eng.). Nucl. Instrum. Methods, 45: 357-8(1966).

A multipurpose collimating system for nuclear scattering chambers is described. It can collimate the incoming particle beam in vertical and in horizontal direction to any suitable size without destroying the vacuum of the system. (B.G.D.)

4740 PRELIMINARY RESULTS IN THE SEARCH FOR FRACTIONALLY CHARGED PARTICLES BY THE MAGNETIC LEVITATION ELECTROMETER. Gallinaro, G.; Morpurgo, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Phys. Lett., 23: 609-13(Dec. 5, 1966).

The operation of the magnetic levitation electrometer suggested previously is described. Measurements on the first five graphite grains (containing altogether $\sim 10^{16}$ nucleons) exclude the presence of quarks in them; a future program of search of terrestrial quarks by this instrument is outlined. (auth)

4741 THE DESIGN OF APPARATUS FOR THE MEASUREMENT OF MOESSBAUER SPECTRA. Bunbury, D. St. P. (Univ. of Manchester, Eng.). J. Sci. Instrum., 43: 783-90(Nov. 1966).

The most frequently used experimental techniques for the observation of the Mössbauer effect are reviewed. The most versatile and most widely used system consists of a negative-feedback controlled electromechanical drive used in conjunction with a multichannel pulse-height analyser, and particular attention is given to the problems encountered in the design of this type of equipment. (auth)

4742 SHAPE OF THE PROJECTED IMAGE OF BUBBLE CHAMBER TRACKS. Morton, W. T. (Univ. of Glasgow). J. Sci. Instrum., 43: 847-8(Nov. 1966).

The shape of the projected image of charged particle tracks formed in a bubble chamber working in a magnetic field was investigated. (auth)

4743 SIMPLE SINGLE-COIL PROBE FOR PULSED NUCLEAR MAGNETIC RESONANCE. McKay, R. A.; Woessner, D. E. (Mobil Oil Corp., Dallas). J. Sci. Instrum., 43: 838-40 (Nov. 1966).

The circuit of the single-coil system for pulsed nuclear magnetic resonance is analyzed in detail. A simple and effective probe with an active damper of pulse transients and with a preamplifier is described. (auth)

4744 DETERMINATION OF DEUTERIUM CONTENT IN LOW CONCENTRATION WATER SAMPLES BY INFRA-RED SPECTROMETRY. Hallaba, E.; Hamza, M. S. (Atomic Energy Establishment, Cairo). Isotopenpraxis, 2: 394-6(Oct. 1966).

The deuterium content of water was determined in the low range by the infrared spectrometric method with a Perkin-Elmer Model 337 spectrophotometer. By using an absorption band at 3.98 μ and a quartz cell of ~0.3 mm thickness, an accuracy of ±0.0005 mole % was obtained. The results are comparable with those obtained by mass spectrometric analysis. (F.S.)

4745 OPERATIONAL PRINCIPLE AND DESIGN OF AN IONIZATION SMOKE-GAS SIGNAL SYSTEM. Vote, Kh. K.; Shultse, Kh.; Khilbig, Kh.; Nennioff, N. (Inst. of Applied Radioactivity, Leipzig). 12p. (In Russian). (CONF-641024-9). DTIE.

From Symposium on Use of Radioisotopes, Warsaw.

A smoke detector was designed which is based on the significant decrease in the ionization current in an ionization chamber when smoke enters the chamber due to neutralization of the ions by submicroscopic particles. The detector case is made of polystyrene for impact resistance. Inside the case are located two ionization chambers and the lamp of an electrometer. Krypton preparations of 2 μCi activity carry the 0.1 amp current. This activity is selected to meet radiation safety regulations but still provide high sensitivity. The current needed for operation is 1.5 ma. The operating voltage may be varied within the limits 200 to 280 volts. Tests on the instrument showed that it began to operate within several minutes in response to a change in temperature 5 meters away. (TTT)

Radiation Effects on Instruments and Instrument Components

4746 (N-66-31669) EFFECTS OF ELECTRON RADIATION ON UNIJUNCTION TRANSISTORS. Flescher, H. L.; Szymkowiak, E. A. (Martin Co., Baltimore, Md.). July 1966. Contract NAS5-3734. 64p. (NASA-CR-526). CFSTI $3.00 cy, $0.65 mn.

The effects of 1.5-MeV electron radiation on three different types of unijunction transistors (12 of each type) were measured. Transistor types tested were 2N1671B, 2N3980, and 2N3484 covering grown, planar, and annular construction, respectively. Parameters monitored before and after irradiation include: interbase resistance, valley voltage, peak point voltage, emitter saturation voltage, intrinsic standoff ratio, interbase modulated current, emitter reverse current, and peak point emitter current. The measured data are tabulated and presented graphically. A summary of the general observations made on each part parameter is given. The data suggest that significant changes, with some bias dependence, occur in the measured parameters at levels that range from about 5×10^{14} to 1×10^{15} e/cm^2 (E = 1.5 MeV) for the devices tested; and that the grown junction constructed device (2N1671B) is susceptible to catastrophic failure at an electron fluence level lower than that for the annular planar and diffused planar constructed devices. The data indicate that the three device types could probably be used satisfactorily at electron fluence levels ranging to about 5×10^{14} e/cm^2. (STAR)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 5067.

4747 (NP-16198) CONTRIBUTION A L'ETUDE DE L'ACTION DES RADIATIONS IONISANTES SUR L'AMIDON. EFFETS DES RADIATIONS GAMMA SUR L'AMIDON DE POMME DE TERRE EN FONCTION DE SA TENEUR EN EAU. (Contribution to a Study of the Action of Ionizing Radiation on Starch. Effects of Gamma Radiation on the Starch of Potatoes as a Function of Water Content). Reuschl, Hans (Institut National de la Recherche Agronomique, Paris (France)). [1962]. 62p. Dep. mn.

Thesis. Submitted to Paris Univ., France.

The effects of radiation at 30 Mrad were studied as a function of the water content chosen from data on the state of fixation on the water in the starch. The modifications of the following physical and chemical characteristics of the irradiated starch were examined: solubility in water and 90% methanol at 20°C, ultraviolet absorption, mean degree of polymerization by viscosimetry, number of functional groups formed and number of modified glucose units. The modifications induced in the glucose units in the macromolecular chains are then studied by paper chromatography. The low molecular weight products present in the extract with 80% alcohol are characterized. The results showed that γ irradiation leads to a degradation of the polysaccharide chains with, in particular, formation of oxidation and dehydration products. The presence of water is shown, in the different reactions studied, as follows: (1) the number of oxidation reactions decreases, (2) the number of chain ruptures remains constant up to a water content of approximately 21% and then decreases, and (3) the quantity of free glucose increases with a water content of approximately 9%. The water exerted a protective effect on the starch in the case of oxidation reactions and chain rupture reactions. There was a chemical intervention in the formation of the glucose. The protection effects can be explained by assuming an energy transfer of the activated glucose units to the water molecules produced by the intermediary of hydrogen bonds and the recombination of fragments favored by their mobility. The mode of intervention of the water is predominant in the case of oxidation reactions and it is particularly marked in the zone of very low hydrations and evolves in the first approximation parallel with the hydration heat. The recombination of fragments becomes evident only at a water concentration above 21%. A consequence of these hypotheses is that the chain rupture reactions are produced at the level of non-protected points by hydrogen bonds such as the oxygen of the glucosidic bond. The release of glucose as a function of the water content of the starch follows a stepped curve with the transition zones lying between 5 and 15 and between 21 and 40%. This evolution leads to the hypothesis that in the starch there are water fractions having a determined mobility. The formation of glucose at water concentrations as low as 0.8% and the presence of hydroxymethylfurfural suggest that the hydrolytic cleavages are produced by way of intramolecular elimination reactions. The modifications induced in the glucose units include the formation of arabinose and xylose units and of a residue whose structure is close to that of glucose. (J.S.R.)

4748 (AEC-tr-6797, Paper 2) ^{90}Sr CONTENT IN THE BONE TISSUE OF THE USSR POPULATION (MATERIALS OF 1964). Marei, A. N.; Knizhnikov, V. A.; Yartsev, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 7p.

Data are presented on the ^{90}Sr content in human bone samples collected in different geographical regions of the USSR during 1964. All results of radiochemical analysis of bones and teeth samples were normalized with reference to the skeleton for adults and children of various age groups. The data are presented in tabular form. (C.H.)

4749 (AEC-tr-6797, Paper 4) ^{90}Sr DISTRIBUTION IN THE SKELETON OF ADULTS. Marei, A. N.; Yartsev, E. I.; Moiseenko, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 7p.

The ^{90}Sr content in parts of different bones of adults is not identical and, as a rule, does not correspond to the average values for the whole skeleton. The relation between the ^{90}Sr content in individual bones and the average concentration in the skeleton was determined by a normalization factor. The values for normalization factors published in 1959 were re-calculated based on measurements of ^{90}Sr content in 20 skeletons of adult persons and in 7 bones (femur, ribs, spine, skull, sternum, pelvis, and jaw), and samples of these bones. The findings are compared with published findings from all parts of the world. (C.H.)

4750 (AEC-tr-6797, Paper 5) STUDY OF EXTRACTED TEETH AS A METHOD OF MASS INVESTIGATION OF ^{90}Sr CONTENT IN THE HUMAN ORGANISM. Marei, A. N.; Knizhnikov, V. A.; Yartsev, E. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 13p.

The feasibility of using extracted teeth as an index to the ^{90}Sr content in the human skeleton was investigated. Data are presented on the ratio of ^{90}Sr in teeth and skeleton of adults in different age groups. The data indicate that teeth/skeleton concentration ratios do not change for persons older than 20 years. Carious teeth were found to contain 9% less ^{90}Sr than sound teeth. Some diseases caused variations in the ^{90}Sr content of teeth. Children's teeth were found to accumulate more ^{90}Sr than the teeth of adults and the accumulation rate was found to be inversely proportional to age. Strontium-90 accumulation was observed in the hard tissues of both temporary and permanent teeth and in fully formed teeth. It was concluded that the analysis of teeth offers a means for determining the ^{90}Sr content of the skeleton in small populations where there is no possibility of obtaining enough samples of bone tissues for accurate measurements. (C.H.)

4751 (AEC-tr-6797, Paper 6) CERTAIN HEALTH ASPECTS OF THE ^{226}Ra PROBLEM. Marei, A. N.; Karmaeva, A. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 10p.

In the locality studied, where radium content is somewhat higher than usual, the quantity ingested by the population with food products is on the average equal to radium ingestion with the drinking water. The somewhat higher levels of radium-226 in the bone tissue of the population are apparently due to substantial ingestion with drinking water and to the particular diet pattern. Calcium contained in drinking water limits radium accumulation in the human bone tissue when the calcium in the food products is sufficient for body requirements. (auth)

4752 ANTIBODIES TO PHOTOPRODUCTS OF DEOXYRIBONUCLEIC ACIDS IRRADIATED WITH ULTRAVIOLET LIGHT. Levine, Lawrence; Seaman, Edna; Hammerschlag, Ellen; Van Vunakis, Helen (Brandeis Univ., Waltham, Mass.). Science, 153: 1666-7(Sept. 30, 1966).

A rabbit immunized with complexes of methylated bovine serum albumin and ultraviolet-irradiated DNA from calf thymus produced antibodies directed toward the photoproducts in the DNA. Serologic activity appeared after irradiation of DNA at 270 mμ and decreased upon irradiation at 235 mμ. The antigenic determinants of the ultraviolet-treated DNA appear to be photoproducts associated primarily with thymine, as measured by direct dependence of serologic activity on the adenine-thymine content of the DNA, and by inhibition of the serologic reaction by the irradiated di-, tri-, and tetra-(thymidine-5'-phosphate) nucleotides. (auth)

4753 REDISTRIBUTION OF FREE SUGARS IN PLANTS AFTER γ IRRADIATION. Uzorin, E. K.; Tokarskaya, V. I. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 292-3(1966). (In Russian).

Carbohydrate balance was investigated in peas subjected to 50kR doses of ^{60}Co γ rays prior to labeling with $^{14}CO_2$. Activity of leaf homogenates and fractions per unit of dry wt, free sugars, and other alcohol-soluble substances were determined. Contents of glucose, fructose, and sucrose were found by chromatographic techniques. The photosynthetic intensity decreased by 14% in the first hrs postirradiation, a level at which it remained up to the 9th day postirradiation. The relative amount of alcohol-soluble substances increased throughout the early postirradiation period, and soluble carbohydrate content was 17% higher nine days afterwards. Concentrations of individual carbohydrates were sharply reduced prior to sudden increases. Amounts of free sugars were redistributed. Rate of respiration in irradiated sprouts was reduced by an average of 50%. The phase character of assimilation dynamics was manifested in the alcohol fraction, in the summary sugar fraction, and in glucose, fructose, and sucrose. (H.G.D.)

4754 HISTOCHEMICAL CHANGES IN ADRENAL GLAND CORTEX OF RATS DURING RADIATION SICKNESS. Truupyld, A. Yu. (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 6: 254-8(1966). (In Russian).

Histochemical changes in the content of ketosteroids, lipids, and ascorbic acid in the rat adrenal cortex during acute radiation sickness induced by a single whole-body x-ray dose of 800 and 1000 R, are of a nonspecific phase character. The primary response of the gland, lasting for one to two days, is expressed in a mobilization of physiologically active substances. The secondary reaction, coinciding with the acute period of radiation sickness, is characterized by temporary reversible inhibition of corticoid synthesis, followed by a compensatory rise in their formation. There is no parallelism in the content of individual physiologically active substances in the gland during acute radiation sickness in rats. An inverse proportionality, characterizing the process of synthetic activity of the secretory cells of the gland, exists between the levels of ketosteroid and lipid contents at various stages of radiation sickness. In the functional respect, the cells of the fascicular zone, especially its outer portion, are the most active. Under conditions of increased hormone production, the cells of the reticular zone are also included in the process of secretion by compensation. (auth)

4755 DISTURBANCE OF GASTRIC SECRETION IN ANIMALS HEMORRHAGING DURING AN ACUTE RADIATION SICKNESS. Mikaelyan, M. G. Radiobiologiya, 6: 210-13(1966). (In Russian).

Dogs were bled from the femoral artery to 4% of the body weight. A transitory decrease was noted in the quantity and quality of gastric juice secreted, as well as a change in the latent period of its secretion. In this case both the conditioned reflex and the neurohumoral regulation of secretion were disturbed. A single whole-body irradiation at an x-ray dose of 600 R caused a wavelike variation of the gastric secretion and latent period of secretion of juice. Periods of hyper- and hyposecretion were observed. Impairment of the conditioned reflex regulation of the activity of the gastric glands was the primary lesion. Irradiation followed by bleeding caused a more profound disturbance of the regulation of secretory activity of the gastric glands, both in the conditioned reflex, and in the neurohumoral phases of the secretory period. (H.G.D.)

4756 PROTECTIVE EFFECTS OF CALCIUM AGAINST ACCUMULATION OF RADIOACTIVE STRONTIUM IN ORGANISMS. Dubrovina, Z. V.; Malkin, P. M. Radiobiologiya, 6: 284-7(1966). (In Russian).

The dependence of radiostrontium deposition on the Ca content in the diet is evaluated quantitatively. At a calcium content in the daily diet of rats from 2 to 150 mg, the dependence of the deposition in the organism of radiostrontium, administered orally, upon the calcium content was satisfactorily described by the sum of two exponential functions with exponents -0.24 and -0.008 or by a power function with exponent -0.52. The protective effect of calcium in the case of oral intake of ^{90}Sr was determined by the amount of calcium absorbed. (H.G.D.)

4757 DISTURBANCE OF ADAPTABILITY OF BLOOD COAGULATION SYSTEM BY RADIATION INJURIES. Andrushko, I. A.; Zubairov, D. M. (Kazan State Medical Inst., USSR). Radiobiologiya, 6: 224-7(1966). (In Russian).

Development of the hemorrhagic syndrome in acute radiation sickness was studied in rabbits x-irradiated with 800 and 1200 R doses. Coagulation time, numbers of thrombocytes and erythrocytes, thromboplastic activity, and capillary strength were determined before and after irradiation and after acute (25%) blood loss from the femoral artery. Blood coagulation was accelerated in non-irradiated controls subjected to bleeding procedures. Radiation injury, however, inhibited increased blood coagulation due to an inhibition of the thromboplastic activity and was accompanied by a reduction in numbers of erythrocytes and thrombocytes. It is concluded that radioinduced injury to the blood coagulation system coincides with an impairment of the adaptive potentialities of the system as the entire adaptive response is disturbed. (H.G.D.)

4758 ROLE OF NONSPECIFIC HUMORAL MEDIATORS IN THE APPEARANCE OF BIOLOGICAL AFFECTS OF IONIZING RADIATION. Santha, A. Rev. Sanit. Mil., 16: Special No., 438-50(1965). (In Rumanian).

Dogs and rabbits were x-irradiated with 200, 400, 800 and 1200 R. Intestinal micromotility increased sharply initially, but then fell much below the normal values. Intestinal absorption of xylose and glucose decreased even in the parabiotic dog (non-irradiated dog sharing circulating blood with irradiated mate). Immunologic studies indicate that necrosin is involved. (JPRS)

4759 ELEVATION OF THE SERUM PROTEIN-BOUND IODINE LEVEL IN INHABITANTS OF THE MARSHALL ISLANDS. Rall, J. E. (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.); Conard, R. A. Amer. J. Med., 40: 833-6(June 1966). (BNL-9632).

Previously, in the course of follow-up examinations of some inhabitants of the Marshall Islands who had been exposed to fallout radiation from a 1954 hydrogen bomb explosion, a high incidence of unexplained elevation of the serum protein-bound iodine (PBI) level was found in both exposed and unexposed subjects. Studies of the kinetics of iodine metabolism in these subjects and work on the nature of the serum iodine are described. Results showed that 20 to 40% of the people living on Rongelap Atoll had elevated serum protein-bound iodine levels without evidence of hyperthyroidism. The increase in PBI seemed to be general throughout the population since the distribution curve of serum PBI was simple. Column chromatography of the serum iodine in 25 normal subjects in the United States showed average values of iodoprotein of 0.8 μg% and of thyroxine plus triiodothyronine of 3.8 μg%, whereas in the Marshallese the average iodoprotein level was 2.2 μg% and thyroxine plus triiodothyronine 4.5 μg%. The high iodoprotein levels appeared to account for the increase in serum PBI in the Marshallese. The thyroidal iodide clearance and the renal iodide clearance in the Marshallese were both depressed to $\sim$one-half normal. The amount of iodine secreted by the thyroid in the Marshallese was estimated to be 76 μg/day. No explanation for the depressed thyroidal iodine uptake rate and renal excretion rate is available at this time. (BBB)

4760 EFFECT OF SHORT-WAVE ULTRAVIOLET IRRADIATION ON THE LUMINESCENCE OF BIOLOGICAL OBJECTS, INDUCED BY THE LONG-WAVE ULTRAVIOLET PART OF THE SPECTRUM. Tsellarius, Yu. G. (Inst. of Cytology and Genetics, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 167: 681-2(Mar. 21, 1966). (In Russian).

Previous studies revealed that action of short-wave ultraviolet radiation on biological objects induces photochemical processes which affect specifically the amino acids. Examination of tissue sections exposed previously to shortwave ultraviolet radiation, then irradiated at the long-wavelength portion of the ultraviolet spectrum resulted in a strong enhancement of the luminescence. The "photochemical fluochromation" of the tissue was studied on dry specimens and on tissue kept in isotonic salt solution, 8% saccharose solution or in glycerol. The short-wavelength exposure (250 to 300 mμ) was carried out with a mercury-quartz lamp and gaseous chlorine and bromine filters; the luminescence was excited with the same light source, using a filter that yielded a radiation corresponding to the 365 mμ line of mercury. Treatment of the tissue in formalin increased somewhat the intensity of the luminescence; the same effect was observed also with albumens. The mechanism involved is not clarified yet. (TTT)

4761 MUTATION RELEASE. Schwanitz, F. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik, 8: 500-5(Nov. 1966). (In German).

As an introduction to a discussion of mutation release the structure and function of the important factors of the gene and chromosome are described. The results of mutations are illustrated. The increase of the mutation rate by mutating agents is considered and the effect of various types of radiation on mutation release are discussed. Mutation breeding as a practical application of mutation release is considered. (J.S.R.)

4762 INFLUENCE OF HIGH-FREQUENCY GASEOUS DISCHARGE ON FORMING FREE RADICALS IN AMINO ACIDS. Mochalkin, A. I.; Buevich, Yu. A. (All-Union Scientific-Research Inst. of Phytopathology, Ministry of Agriculture, USSR). Radiobiologiya, 6: 202-5(1966). (In Russian).

A high-frequency gas discharge is a highly effective influence promoting the formation of free radicals in amino acids, a 10 to 15 min exposure being equivalent to γ-irradiation at a dose of 1 to $2 \cdot 10^6$ R. The EPR spectra of the 20 most important amino acids, irradiated by γ rays or in a gas discharge, coincide in form. Valine is an exception to this rule. The high effectiveness of the discharge is explained by the action on the amino acids of short-wave radiation (uv and x rays) generated in the plasma. (auth)

4763 EFFECTS OF IONIZING RADIATION ON THE DYNAMICS OF FREE AMINO ACID DISTRIBUTION IN THE WALLS OF INTESTINAL TRACT. Volynskii, A. S.; Khadzhiev, K. Kh.; Kleiner, S. I. (Tashkent State Medical Inst.). Radiobiologiya, 6: 170-3(1966). (In Russian).

The content of free amino acids was determined in various portions of the gastrointestinal wall in non-irradiated rabbits and in rabbits given 300, 500, 700, or 900 R doses of x rays. The complement and content of free amino acids was specific for each portion of the gastrointestinal tract observed. Maximum assimilation of amino acids was found to be in the jejunum, and with the exception of the histidine content in the stomach wall, the free amino acid content in this portion of the intestine was greatest. Except for glutamic acid, aspartic acid, and alanine, the content of free amino acids was decreased in irradiated animals, a drop that was the most pronounced at the 900 R dose. It is suggested that the reduction in amino acid content post-irradiation may be due to radioinduced activation of the transamination process. (H.G.D.)

4764 FRACTIONATED IRRADIATION INFLUENCE ON CHANGES IN CHOLESTEROL CONTENT IN BLOOD SERUM OF GUINEA-PIGS AND DOGS. Korotkova, V. P. (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 6: 194-201(1966). (In Russian).

Fractionated irradiation of guinea pigs at doses of 50 and 200 R and 100 and 200 R at 10-day intervals promoted a 35 to 55% increase in the survival rate and an increase in the lifetime in comparison with the control group. Repeated x-irradiation in increasing doses promotes an increase in the radioresistance of the dogs: the animals survive summary doses four to five times as great as the lethal dose (3350 R), while the lifetime is increased five to ten-fold (92 to 178 days). The degree of radioresistance in this case varied depending upon the scheme of preliminary irradiation. In all the variations of tested doses, a decrease in the number of leukocytes was observed; in this case the degree of leukopenia corresponded to the value of the radiation dose. In the intervals between the repeated irradiations, in not one of the experimental variations did the leukocytic curve return to the normal level. In the case of a single whole-body irradiation of guinea pigs at doses of 400 and 500 R, a drop in the cholesterol level was noted on the third to 14th days. In the case of irradiation at a dose of 600 R, an increase in the cholesterol was observed immediately after irradiation and on the fourth day, without a return to normal up to the death of the animal. Fractionated irradiation was accompanied by fluctuations in the cholesterol level within the normal limits. Whole-body x-irradiation of dogs at a dose of 700 R (lethal dose) produces a sharp rise in the blood cholesterol 24 hrs afterwards, lasting to the death of the animal. Under conditions of fractionated irradiation, no sharp fluctuations in the cholesterol content were observed. After each repeated irradiation, a labile equilibrium was established, with a tendency for deviation of the cholesterol concentration in the direction of a decrease from the norm. (auth)

4765 INFLUENCE OF WHOLE-BODY X-IRRADIATION ON SOLUBLE PROTEINS OF SKELETON MUSCLES. Makhlina, A. M. (Leningrad State Univ.). Radiobiologiya, 6: 174-8(1966). (In Russian).

Radioinduced changes in the thermal stability of soluble proteins in muscle tissue was investigated in x-irradiated rabbits (4000 R) and rats (1200 R). Five basic fractions were determined by electrophoretic separation of unheated extracts of soluble muscle proteins of control and irradiated rabbits: six were determined in rat proteins. The greatest protein content among the control and experimental animals was found in the fifth fraction. Muscle proteins of rabbits were more thermolabile and more radioresistant than those of rats, which indicates a species specificity for muscle proteins. (H.G.D.)

4766 EFFECT OF NEUTRON IRRADIATION ON TISSUE METABOLISM PROCESSES. Cherkasova, L. S.; Koldobskaya, F. D.; Kukushkina, V. A.; Mironova, T. M.; Remberger, V. G.; Taits, M. Yu.; Fomichenko, K. V. (Inst. of Physiology, Minsk). Radiobiologiya, 6: 179-84(1966). (In Russian).

The effects of neutron bombardment on carbohydrate, energy, and protein metabolism were studied at relatively low doses. Changes in free and bound glycogen, glucose-1-phosphate, glucose-6-phosphate, fructose-1, 6-diphosphate, triose-phosphate, phosphopyruvate, ATP, creatine phosphate, phosphorylase, amylase, succinic dehydrogenase, respiratory quotient, and protein content were determined in the central nervous system, skeletal muscle, and liver of adult white rats 15 to 30 days after whole-body irradiation with 0.04 to 1.35 MeV neutrons. While the glycogen content of the brain increased temporarily at 15 days and then decreased progressively, that of muscle decreased only at 15 days. The synthesis of bound glycogen was definitely inhibited 30 days after irradiation, and disruption of the coordination of glycogen metabolism was shown by the phosphorylase and amylase values. There were no significant changes in the phosphorylated intermediates of carbohydrate metabolism, but the reactions from glucose-6-phosphate through fructose-1, 6-diphosphate to triose-phosphate seemed to be inhibited in the brain, while that from glucose-1-phosphate to glucose-6-phosphate was accelerated in skeletal muscle. The levels of ATP and creatine phosphate were unchanged in the brain and somewhat increased in muscle. Although the changes in succinic dehydrogenase and QO_2 were insignificant, there was some increase in protein synthesis 30 days after irradiation. (ATD)

4767 EFFECTS OF PARATHYROID EXTRACT ON REMOVAL OF ^{89}Sr, ^{45}Ca, AND ^{32}P BY HEMODIALYSIS FROM CONSCIOUS CALVES. **Perry, S. C.; Cragle, R. G.; Downey, H. F.; Stewart, W. E.; Short, C. E. (Univ. of Tennessee, Oak Ridge). J. Dairy Sci., 49: 674-9(June 1966).**

Mobilization of Ca, Sr, and P was studied in calves under the influence of different levels of parathyroid hormone, hemodialysis being chosen to study the metabolism of these elements because the procedure is specific for these substances and avoids the impairing side-effects of chemical methods. Nine fasted calves were given one of 3 treatments: (A) thyroparathyroidectomy, (B) thyroparathyroidectomy plus parathyroid extract (PTE) and (C) control mock-operation. Strontium-89, ^{45}Ca, and ^{32}P were injected intravenously 48 hr before the 16-hr dialysis period. Surgery was performed 22 hr before dialysis. The PTE was given intramuscularly at 2-hr intervals, beginning at the initiation of dialysis (6.6 USP units/kg/day). Treatments did not significantly affect the accumulation of total Ca or P in the dialyzing baths. However, the ^{89}Sr/^{45}Ca ratio of activities in the baths was significantly increased by PTE. Reduction of plasma ^{45}Ca activity during dialysis averaged (A) 28%, (B) 53%, and (C) 51%. Treatment with PTE significantly reduced ^{89}Sr in epiphyseal bone, and all treatments resulted in an incorporation of ^{45}Ca into the rib epiphyses. The PTE group (B) had the greatest reduction of ^{89}Sr activity and also the greatest incorporation of ^{45}Ca into the rib epiphyses during dialysis. Accumulation of ^{89}Sr and ^{45}Ca in the dialyzing baths, reduction of ^{45}Ca activity in plasma, and relative ^{89}Sr and ^{45}Ca activities of rib epiphyses indicate that PTE administration resulted in a release of ^{89}Sr from the epiphyses, with a preferential incorporation of ^{45}Ca during dialysis. (BBB)

4768 STRUCTURAL AND FUNCTIONAL DISTURBANCES OF THE PANCREAS ISLANDS OF LANGERHANS IN ANIMALS SUFFERING FROM RADIATION SICKNESS INDUCED BY RADIOACTIVE STRONTIUM. Khomutovskii, O. A. Radiobiologiya, 6: 214-18(1966). (In Russian).

Microscopic, submicroscopic, and functional changes in the pancreatic islets during long periods of radiation sickness induced by ^{89}Sr or ^{90}Sr and observed in guinea pigs and rats indicated that a light form of diabetes appeared. A disturbance of the process of tissue regeneration occurred in the islet apparatus: proliferation of β cells with unusual structure, cells of the duct epithelia, and vigorous development of connective tissue were noted. During the process of pathological regeneration atypical submicroscopic structures and organoids appeared very early in the β cells. The injurious action of beta radiation was proportional to the amount of absorbed energy at the early stages, but the disturbance of regeneration of the islet apparatus depends less upon the amount of absorbed energy acquired at the first stage of radiation sickness. (H.G.D.)

4769 STRONTIUM AND CALCIUM ACTION IN GOAT ORGANISM. Panchenko, I. Ya.; Sarapultsev, I. A. Radiobiologiya, 6: 228-31(1966). (In Russian).

Strontium metabolism was compared with that of calcium in lactating goats given ^{90}Sr – strontium nitrate and ^{45}Ca – calcium chloride orally or intravenously. Calcium-45 and ^{90}Sr were determined in bones, milk, urine, and feces. Assimilation of ^{90}Sr and ^{45}Ca from the gastrointestinal tract comprised 7 and 20% of the introduced dose, respectively. Strontium-90 excretion exceeded that of ^{45}Ca regardless of the pathway of isotope administration. Observed ratio (OR) of isotope content in the diet to whole-body content was 0.24 and to milk content, 0.08. A discrimination of Sr with respect to Ca was noted in the process of assimilation from the gastrointestinal tract and in urinary excretion, while the OR of milk to dietary content was attributed to the discrimination of Sr with respect to Ca both in the process of gastrointestinal assimilation and lactation. No discrimination of ^{90}Sr with respect to ^{45}Ca was observed in the ratio of blood content to bone content. (H.G.D.)

4770 RADIATION EFFECTS ON GLYCOLYTIC OXIDATION-REDUCTION. Fomichenko, K. V. Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 1, 73-7(1962). (In Belorussian).

The gray and white matter of the cerebral hemispheres, the cerebellum, and the spinal cord of ^{60}Co gamma-irradiated rabbits (2 to 3 kg) were examined for glycolytic activity. For 15 to 30 days after the irradiation, the rate of anaerobic glycolysis was high in all parts of the central nervous system both with and without added glucose as substrate. Sixty days after the irradiation the anoxidative energy exchange in the brain was normal in the presence of added substrate but high in its absence. Ninety days after the irradiation in the absence of substrate the glycolysis rate was high in all parts of the central nervous system, but in its presence the rate was high only in the white matter and the spinal cord, with no difference from the controls in the gray matter and the cerebellum. The data obtained verify hypotheses that have been expressed concerning the radiation sensitivity of the central nervous system. Differences in the exchange reaction were related to differences in anatomy and function of different parts of the central nervous system. (TTT)

4771 EFFECT OF GAMMA IRRADIATION ON THE DIAGNOSTIC POTENTIALITIES OF SOME BIOLOGICAL PRODUCTS. Chelemen, N.; Ciortea, G.; Savulescu, M. Rev. Sanit. Mil., 16: Special No., 505-8(1965). (In Rumanian).

Radiation effects on brucella antigen and on immunogenicity of tuberculin were studied in guinea pigs. The brucella antigen irradiated 10^5 R changed in agglutinability and became unsuitable for diagnostic use. Tuberculin was unaffected for all practical purposes. (JPRS)

4772 EFFECT OF DOCA AND ACTH ON RETENTION AND ELIMINATION OF ^{137}Cs IN MICE. Derecki, Iuliusz. Rev. Sanit. Mil., 16: Special No., 451-3(1965). (In Rumanian).

Three groups of 10 mice each received ^{137}Cs (as chloride), and then either DOCA or ACTH. While the corticosteroid seemed to accelerate elimination of the radioisotope, ACTH tended to have the opposite effect. (JPRS)

4773 SUCCINOXIDASE ACTIVITY OF THE RAT HEART AFTER WHOLE-BODY GAMMA IRRADIATION. Easley, J. F.; Shirley, R. L.; Davis, G. K. Quart. J. Florida Acad. Sci., 28: 285-8(1965).

Rats were exposed to 1000 R of whole-body ^{60}Co gamma irradiation at the rate of 40 R per minute and succinoxidase activity determined in the ventricle of the heart when the rats were sacrificed at 0.5 and 36-hour intervals after irradiation. Succinoxidase activity increased in the heart ventricle by 18% during the 36-hour post-irradiation period when expressed on the basis of oxygen uptake per milligram of nitrogen. The increase was 19% when expressed on the basis of activity per gram wet weight, and 12% on the basis of whole heart after the heart weights were adjusted to the average weight of hearts within the various treatment groups. (auth)

4774 CYTOCHEMICAL STUDIES OF ACTIVITY OF ENDOGENOUS REDUCTASES IN SPERMATOZOA. III. EFFECT OF IONIZING RADIATION ON THE MOTILITY AND ACTIVITY OF ENDOGENOUS REDUCTASES AND SUCCINODEHYDROGENASE OF THE EJACULATED BULL SPERMATOZOA. Hrudka, F.; Horakova, A.; Horak, J. (Coll. of Agriculture, Kosice, Czech.). Vet. Med. (Prague), 11: 361-70(June 1966). (In Czech).

Motility of spermatozoa from bulls was reduced by radiation doses of 2000 to 5000 R after washing, whereas a dose of 10,000 R was required for the same effect in unwashed spermatozoa. Succinodehydrogenase was more radioresistant than endogenous reductases. Radiation decreased the activity of the enzymes after a certain period of latency. The inhibition started slowly and increased linearly. A solution of 0.15M NaCl increased the radiosensitivity of the reductases, but did not affect the succinodehydrogenase. (TSS)

4775 INTERFERON PRODUCTION IN CHICK EMBRYO CELLS. II. THE ROLE OF DNA. Burke, D. C.; Morrison, J. M. (Univ. of Aberdeen, Scotland). Virology, 28: 108-14 (Jan. 1966).

The role of DNA synthesis in interferon production was explored by the use of uv irradiation and chemical inhibitors of DNA formation. When chick embryo cells were irradiated with uv light, both DNA and RNA synthesis was inhibited, the effect increasing with the period of irradiation. DNA synthesis was more sensitive to uv irradiation than RNA, in agreement with earlier finding. Interferon yield was also depressed by uv irradiation with a sensitivity intermediate between that of DNA and RNA synthesis. No conclusion as to the role of DNA synthesis could be drawn from these results, since it was not possible to inhibit DNA by uv radiation synthesis without also affecting RNA synthesis, but they did indicate the dependence of interferon production on cellular RNA synthesis. Small doses of aminopterin and 5-iodo-2-deoxyuridine (IUDR) inhibited DNA synthesis in chick embryo cells without any effect on the production of interferon, showing that DNA synthesis is not necessary for interferon formation. Larger doses of IUDR inhibited cellular RNA synthesis and also depressed interferon production, indicating a requirement for RNA synthesis in interferon production. Doses of mitomycin C which reduced the yield of interferon depressed cellular RNA and protein synthesis, and also caused breakdown of cellular DNA. The interpretation of the effects of these inhibitors is discussed. (BBB)

4776 SYNTHESIS OF INOSINIC ACID, INOSIN, AND HYPOXANTHINE IN PIGEON LIVER AT EARLY STAGES FOLLOWING IRRADIATION AND INJECTION WITH RADIOPROTECTIVE CHEMICAL. Romantsev, E. F.; Khalikov, S. K. Radiobiologiya, 6: 268-71(1966). (In Russian).

Pigeons were irradiated with the minimum lethal dose (3000 R) of γ rays, and liver homogenate was incubated with ^{14}C-2-formic acid. The synthesis of inosinic acid, inosine, and hypoxanthine was unchanged 10, 30, and 60 min after irradiation. Intraperitoneal administration of β-mercaptopropylamine (MPA) to healthy pigeons distinctly inhibited the synthesis of the purine compounds 10, 36, 56, and 86 min after the introduction of aminothiol. Preliminary (before irradiation) administration of MPA to pigeons reduced the synthesis of inosinic acid, inosine, and hypoxanthine to the same level as after the administration of the aminothiol without subsequent irradiation. (auth)

4777 ESTIMATION OF INTERNAL STRONTIUM CONTAMINATION FROM URINE EXCRETION RATES. Pusch, W. M. Atomkernenergie, 11: 503-7(1966). (In German).

The mechanism of strontium excretion after acute intake has been explained by various formulae. Comparisons of the formulae are made in this study. A mean urine excretion curve was selected which represented strontium metabolism of a typical person. Procedures for obtaining information for body burden calculation are described. Methods for assessment of strontium exposure dose from urine excretion data are explained. (H.L.W.)

4778 INFLUENCE OF PRE-PROCESSING WITH SUBSTRATE ON THERMAL AFTER-EFFECTS IN UV-IRRADIATED TRYPSIN. Luzikov, V. N.; Troshkina, T. V. (Moscow State Univ.). Radiobiologiya, 6: 328-9(1966). (In Russian).

The inhibitory effects of substrate on thermal inactivation of irradiated enzyme solutions were studied in uv-irradiated trypsin to which five volumes of the ethyl ester of N-benzoyl-L-arginine in 0.05 M phosphate buffer were added. Another portion of the irradiated solution was mixed in a 1 : 5 ratio with a solution of the ester preliminarily hydrolyzed. Hence the radioprotective effect was attributed to conversion of the damaged enzyme molecules to the native form as a result of reaction with the substrate. (H.G.D.)

4779 CHANGE IN THE ACTIVITY OF GLUTAMIC-ALANINE AND GLUTAMIC-ASPARAGINE TRANSAMINASE AFTER X-IRRADIATION. Pikulev, A. T.; Yakubovick, L. S. Nauch., No. 1, 90-3(1966). (In Russian).

Rats were given 100 R x radiation. After 1, 2, and 24 hours, the activities of glutamic-alanine and glutamic-asparagine transaminases were determined in the liver, kidneys, spleen, and heart muscle. There was a decrease in the activity of glutamic-alanine transaminase in all time intervals following irradiation. There was a phase character in the changes of glutamic-alanine transaminase activity in the heart muscle and kidneys, as well as of the glutamic-asparagine transaminase activity in all organs. (H.L.W.)

Ecology

4780 PREDICTING THE ^{90}Sr UPTAKE IN FISH. Rovinskii, F. Ya.; Agre, A. L. (Inst. of Applied Geophysics, Moscow). Gig. Sanit., No. 8, 117-19(Aug. 1966). (In Russian).

A radiochemical method was used for determining the amount of ^{90}Sr in fish and in lake water; stable Sr was determined by flame-photometric method and Ca by trillonometric method, with the order of error not exceeding 15%. The tabulated results of K_n measurements for ^{90}Sr, Sr, and Ca showed a relation between the K_n of ^{90}Sr and the type of the fish in which it was determined. The highest K_n of ^{90}Sr was found in perch (~ 270) and the lowest in year-old carp (~ 130). In the crucian carp it was ~ 190. The same was observed with the uptake of Sr^{2+} and Ca^{2+}. The ratio of the uptake coefficient for radioactive and stable Sr was equal to 1 (1.03 ± 13%). After a certain span of time, an equilibrium was established between the fish organism and the environment, such that the ratio ($^{90}Sr/Sr^{2+}$) in the fish was equal to the ratio ($^{90}Sr/Sr^{2+}$) in the water. Disturbances in mineral exchange between fish and water media occur due to radiation injuries in fish. (R.V.J.)

Genetics and Cytogenetics

Refer also to abstract 4837.

4781 X-RAY-INDUCED MUTATION IN EXTRACELLULAR BACTERIOPHAGE T_4. Brown, Douglas F. (Chalk River Nuclear Labs., Ont.). Mutat. Res., 3: 365-73(Oct. 1966).

Two kinds of experiments were performed to test for a mutagenic effect of x rays on extracellular bacteriophage T_4: the frequencies of r and r-mottled plaques were determined in platings of irradiated and unirradiated wild-type T_4 phage; and the frequencies of r_{II}^+ reverse mutants were measured in the progenies of irradiated and control T_4 r_{II} phage. In both kinds of experiments, the frequency of the mutant type was increased by irradiation of the extracellular phage. Reconstruction experiments, in which artificial mixtures of r_{II} and r_{II}^+ phage were irradiated, showed that only a minor part of the radiation-induced increase in r_{II}^+ frequency could be accounted for by selection in favor of already-existing r_{II}^+ revertants. The results indicate that genes can be induced to mutate by exposure to ionizing radiation in the absence of any metabolic activity. A multihit mechanism for the induction of mutations was indicated by the dose-response curve for the frequency of r_{II}^{+} revertants in progenies from irradiated r_{II} phage. The chemical changes involved are unknown. (auth)

4782 THE GENETIC CONSTITUTION OF THE RADIATION-SENSITIVE MUTANT ESCHERICHIA COLI B_{s-1}. Mattern, Ina E.; Zwenk, H.; Roersch, A. (TNO, Rijswijk, Netherlands). Mutat. Res., 3: 374-80(Oct. 1966).

The radiosensitive strains *Escherichia coli* B_{s-1} and B_{s-2} are both unable to repair uv- and x-ray damage in their DNA; in addition the B_{s-1} strain is also unable to repair certain uv-irradiated bacteriophages. In this respect the latter strain resembles Hcr$^-$ mutants of *E. coli* K12 strains, which are also uv sensitive, but, in contrast to *E. coli* B_{s-1}, x-ray resistant. By means of transduction analysis with phage P1kc it is shown that strain B_{s-1} is in fact a double mutant, carrying an Hcr$^-$-like mutation, located on the chromosome near the *gal* locus, and a second mutation near *met*$_3$, denoted *exr*$^-$, which is responsible for the x-ray sensitivity. Both mutations influence the uv sensitivity of the B_{s-1} strain. The B_{s-2} mutant contains the *exr*$^-$ mutation only, which also accounts for the uv sensitivity of this strain. (auth)

4783 PROPERTIES OF FOUR MUTANTS OF ESCHERICHIA COLI DEFECTIVE IN GENETIC RECOMBINATION. van de Putte, P.; Zwenk, H.; Roersch, A. (TNO, Rijswijk, Netherlands). Mutat. Res., 3: 381-92(Oct. 1966).

Various properties of four mutants of *Escherichia coli* CR 34, defective in genetic recombination (Rec$^-$) were studied. The mutants are more sensitive to uv- and x-irradiation, in comparison with the wild-type strain, but are able to propagate irradiated bacteriophage λ like the wild type. The mutants are able to conjugate with F′ strains and to maintain the F factor. In crosses with Hfr strains the appearance of stable recombinants is delayed until the entrance of the allelic *rec*$^+$ marker of the donor in the Rec$^-$ recipient. Therefore the *rec*$^+$ allele must be dominant over the *rec*$^-$ allele. This allows the determination of the approximate position of the *rec*$^-$ mutations on the chromosome. Three different sites appear to be involved; two mutations (*rec*$^-_{35}$, *rec*$^-_{38}$) are most probably located near *thr*, one (rec$^-_{36}$) between S^r and *his* and one (*rec*$^-_{34}$) probably between *try* and *his*. Derivatives of the Rec$^-$ mutants, lysogenic for λ, show different uv prophage induction patterns. Recombination among genetically-marked λ phages is not restricted in any of the Rec$^-$ strains. (auth)

4784 RECOVERY FROM THE MUTAGENIC EFFECT OF ULTRAVIOLET IRRADIATION IN OPHIOSTOMA. Zetterberg, G. (Uppsala Univ.). Mutat. Res., 3: 393-409(Oct. 1966).

When cells from two auxotrophic mutants of *Ophiostoma multiannulatum* are irradiated with uv light the frequency of revertants to wild type decreases if the cells are incubated in liquid medium following uv irradiation. The decrease is dependent on an enzymatic process, energy requiring and temperature dependent, and ceases when the cells are starved of nitrogen or glucose or treated with sodium azide. The decrease in mutation frequency also stops when the cells are plated by mixing them with the agar substrate. The cells exude into the liquid medium compounds with nucleic acid absorption, and these compounds induce reversions in a hypoxanthineless strain. The results are discussed and compared with similar observations on modification of uv-induced mutation frequency and lethality in bacteria. (auth)

4785 THE INFLUENCE OF THE CYTOPLASM ON MUTATION IN ASPERGILLUS NIDULANS. Arlett, C. F. (Atomic Energy Research Establishment, Wantage, Eng.). Mutat. Res., 3: 410-19(Oct. 1966).

A cytoplasmic variant of *Aspergillus nidulans* line 29y produced two classes of conidia, variant and normal. On minimal medium the variant conidia were more resistant to uv than normal conidia. After γ-irradiation there were no differences in survival. High mutation rates to 8-azaguanine resistance were detected when the normal conidia of line 29y were treated with uv- or γ-irradiation. No 8-azaguanine resistant mutations were recovered when the variant conidia were irradiated. The data indicate that the difference in mutation rate was at least a 1000-fold. The cytoplasmic control of the differences in uv survival and induced mutation rates between the two classes of conidia was confirmed when the cytoplasm from line 29y was tested in combination with the nucleus from the line 29. It was possible to introduce the resistant mutation into the variant line 29y by heterokaryosis. This manipulation confirmed the cytoplasmic origin of the morphological differences between the two classes of conidia. It was not possible to distinguish between the two classes of conidia on the basis of the induced mutation rate to 6-methylpurine resistance. (auth)

4786 CHROMOSOMAL ABERRATION TYPES IN THE LEUCOSITES OF PERIFERAL BLOOD OF PATIENTS EXPOSED TO RADIOTHERAPY. Brancadoro, P.; Siciliano, A. (Univ., Rome). Nunt. Radiol., 31: 1403-18(Dec. 1965). (In Italian).

The persistence of the chromosome aberrations is discussed as a function of time after irradiation. Seventeen cases, examined before the irradiation and considered as controls, as well as 6 cases examined from 6 months to 4 years after the therapeutic irradiation are reported. In the irradiated subjects the percentage of the abnormal cells examined by microscopy was of 5.8%, while it was of 0.9% in the controls; the number of the abnormal cells revealed by the karyotypic analysis was 23 out of 123 examined cells in the irradiated subjects, while it was 5 out of 291 in the controls. The significance and the need of performing the karyotypic analysis for the recognition of the stable anomalies are discussed. (auth)

4787 INHERITANCE OF RADIORESISTANCE IN DROSOPHILA. I. Ogaki, Masahiro; Nakashima-Tanaka, Eiji (Univ. of Osaka Prefecture). Mutat. Res., 3: 438-43(Oct. 1966).

Two wild-type strains of *Drosophila melanogaster*, Hikone-H and Mino-H are radioresistant to γ-rays, but a Yamaguchi wild-type strain is radiosensitive, as are also two mutant strains, bw;st ss and vg-ms;se. In general, the females from these strains are more resistant than the males. Reciprocal crosses showed that resistance to radiation is dominant to sensitivity, and that maternal or cytoplasmic effects are negligible. The third chromosome is mainly responsible for radioresistance in these strains, and the locus of the principal gene(s) for radioresistance may be near the right end. (auth)

4788 RADIATION RESPONSE OF DRY SEEDS IN TWO VARIETIES OF TRITICUM DURUM. Avanzi, Silvana; Brunori, Alberto; Giorgi, Benito (National Committee for Nuclear Research, Rome. Univ. of Pisa, Italy). Mutat. Res., 3: 426-37 (Oct. 1966).

DNA cytophotometric analyses of prophases (4C) in growing root tips of two varieties of durum wheat showed that the variety Aziziah has a DNA content per nucleus 6% higher than Cappelli, which in turn has a larger nuclear volume. An analysis of nuclei in the radicle meristem of dry (resting) seeds confirmed the larger nuclear size of Cappelli and the higher DNA content per nucleus of Aziziah. It also showed the contemporary occurrence of nuclei with 2C and 4C DNA contents. Irradiation of resting seeds with both x rays and fast neutrons did not reveal any clear difference in radiation sensitivity, at the chromosomal level, between Aziziah and Cappelli. It was found that the first postirradiation mitoses had chromatid aberrations (cells hit by radiation in 4C (G_2)) and that, among 4C (G_2) cells, presumably late G_2 cells were the most damaged. It was also shown that late G_1 cells in resting seeds responded to radiation with chromatid aberrations. (auth)

4789 NOTE ON THE PAPER BY H. GAUL ON THE IMPORTANCE OF INDUCED MUTATIONS IN SELECTION. Varuntsyan, I. S. Agrobiologiya, No. 5, 771-4(1965). (In Russian).

It is pointed out that H. Gaul who has conducted extensive research and knows the published literature well is skeptical of the value of induced mutations in plant selection. The role of mutations in plant breeding will not be clarified for 5 to 10 years. Gaul believes that macromutations or large genetic changes are of little direct use, and that the micromutations or small genetic changes are of greater potential value. The variability of a trait offers the breeder a possibility of selecting a positive form. The literature data, including the Russian data, ascribes great importance to the large genetic changes in successfully obtaining valuable plant forms. The opinion prevails that the possibilities of mutation selection have been fantastically overestimated. (TTT)

4790 ON SOME CARDINAL QUESTIONS OF THE MODERN THEORY OF MUTATIONS. Dubinin, N. P. (Inst. of Biological Physics, Moscow). Genetika, No. 7, 3-20(July 1966). (In Russian).

The following questions are considered and discussed: The processes of natural mutagenesis in connection with the formation of chromosome rearrangements; the effect of protection in the case of irradiation and the phenomenon of protection absence in the case of small radiation doses combined with protectors preventing chromosome damage when large doses are applied; the question of development of the processes of genetical damage in the case of chemical mutagenesis beginning from the moment of mutagen action up to the phase of DNA synthesis when the realization of primary changes takes place; the questions of resonance-, prolonged- and chain-like mutagenesis; the question bearing on the basis approach to the solution of the problem of directed mutations. (TSS)

Health Physics and Safety

Refer also to abstracts 4620 and 5316.

4791 (AD-632219) EXPERIMENTAL EVALUATION OF SIMULATED HEAT AND MOISTURE LOADS IN SHELTERS.

Final Report. Goldsmith, Alexander (IIT Research Inst., Chicago, Ill.). Dec. 1965. Contract OCD-OS-62-227. 185p. CFSTI $5.00 cy, $1.25 mn.

An experimental program was carried out to determine the variation of temperatures inside a fallout shelter, and in the surrounding soil, under conditions of simulated occupancy. Variables investigated included the ventilation rate, and the size and shape of the shelter structure. The experimental shelters had floor areas of 21 × 21, 21 × 7, and 7 × 7 ft., all with a 7 ft. ceiling height, and were loaded with 45, 15, and 5 simulated occupants respectively. Each shelter was ventilated at constant rates of 0, 3, 7, and 15 cfm per occupant for periods up to two weeks. The supply air was maintained at a constant dew-point temperature of 69F and a dry-bulb temperature that varied sinusoidally between 75 and 95F each day. Detailed test data are given for the variation of temperatures with time and location. (STAR)

4792 (AD-634998) ADOPTION OF PUBLIC FALLOUT SHELTERS: A 1966 NATIONAL STUDY. El Klonglan, Gerald; Beal, George M.; Bohlen, Joe M.; Coward, Walter, Jr. (Iowa Agricultural and Home Economics Experiment Station, Ames). 1966. Contract OCD-PS-65-9. 44p. CFSTI $2.00 cy, $0.50 mn.

A survey was made on the attitude of the public toward fallout shelters. A series of questions designed to determine the extent to which individuals had adopted the idea of using public fallout shelters in case of nuclear attack was used as the basis for the survey. (C.H.)

4793 (EUR-2998.f) VALEUR DE LA SPECTROMETRIE GAMMA APPLIQUEE AUX ECHANTILLONS BIOLOGIQUES. (Value of Gamma Spectrometry Applied to Biological Samples). Tanguy, H.; Camera, V. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). July 1966. 20p. Dep. mn.

The analysis of biological samples has fewer applications than whole-body counting, nevertheless it has value when applied to biological specimens such as urine and feces. The authors establish the normal spectra for urine and feces and find a net increase in ^{137}Cs in urine after the middle of 1963. Body burdens calculated from the concentrations in the urine were higher than in other places where the same measurements were done. The authors report results on spectra of some cases of slight contamination that were found at Ispra. Contamination was due to ^{203}Hg, ^{134}Cs, ^{152,154}Eu and other uranium fission products. (auth)

4794 (N-66-30785) NOTE ON THE DOSIMETRIC INTERPRETATION OF RIGIDITY SPECTRA FOR SOLAR PARTICLE BEAMS. Schaefer, Hermann J. (Naval School of Aviation Medicine, Pensacola, Fla.). Apr. 26, 1966. 20p. (NASA-CR-76283; NAMI-960). CFSTI $3.00 cy, $0.65 mn.

Three flux/rigidity spectra are established theoretically covering the full variability range of all flare events of the past solar cycle and are evaluated dosimetrically. It is found that, of the components heavier than protons, only α particles contribute substantially to total exposure. The fractional α dose in the tissue surface behind 0.1 g/cm^2 shielding grows from 40% for P_0 = 50 MeV to 400% for P_0 = 300 MeV. The α dose shows a much steeper drop with increasing depth than the proton dose and would require microsensors for accurate measurement. For the alpha and medium heavy components, the relative biological effectiveness (RBE) shows a pronounced transition in near surface regions which further steepens the drop of RBE dose equivalents as compared to rad doses. The extremely strong and nonlinear dependence of the rad and rem dose distribution on rigidity sharply limits the usefulness of the rigidity concept for dosimetric evaluations and indicates the need for direct measurements of local rad and rem doses on the astronaut's body. (auth)

4795 (NP-16352) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 3, Number 5. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). May 1965. 34p. Dep. mn.

I. A report is given on the safety of radioisotopes in industry. Data are presented on the rate of increase of uses of radioisotopes as measured by the number of new radioisotope licenses and license amendments issued in Canada over recent years. Additional data on the number of radiation accidents which have occurred in Canada over the same period are presented. There has been no significant change in the number of over-exposures over the years in spite of the increased use of radioisotopes. II. Canadian fallout data for April, 1965, are given. Data on air, precipitation and milk are tabulated. The air data are given in terms of gross beta activity per cubic meter of air. Tables are given to show the total beta activity per square kilometer in precipitation and the strontium-90 and cesium-137 concentrations in precipitation. Strontium-90 and cesium-137 determinations on milk samples are tabulated. III. Reactor environment monitoring data for April, 1965, are given. Total alpha activity and total beta activity in water samples are tabulated. Results of analysis of water samples for strontium-89, strontium-90 and cesium-137 are also tabulated. Total beta activity measurements on air filter samples in proximity to the McMaster University reactor are tabulated. (H.L.W.)

4796 (SC-R-66-959) SAFETY IN A CHEMISTRY LABORATORY. Elsbrock, R. G. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 36p. (CONF-661029-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Chemical Safety, Albuquerque, N. Mex.

Safe practices in handling hazardous chemicals are discussed. Topics covered include: rules for laboratory safety, chemical hazards, housekeeping, safety equipment, and laboratory manipulations. (M.C.G.)

4797 (AEC-tr-6797) USSR REPORTS ON NATURAL AND ARTIFICIAL RADIOACTIVITY IN DIET AND MAN. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). Translated for New York Operations Office, Health and Safety Lab., N. Y. 70p. Dep. mn. CFSTI $3.00 cy, $0.75 mn. JCL $6.60 fs, $2.30 mf.

Translations are presented of five papers submitted to the United Nations Scientific Committee on the Effects of Atomic Radiation by the USSR. One paper was abstracted previously and appeared in NSA Vol. 20 as number 42741. (C.H.)

For abstracts of individual papers see: 4748, 4749–4751, and 4798.

4798 (AEC-tr-6797, Paper 1) INGESTION OF FALLOUT WITH FOOD AND WATER BY THE POPULATION OF THE SOVIET UNION DURING 1963–1964. Knizhnikov, V. A.; Stepanov, Yu. S.; Petukhova, E. V.; Barkhudarov, R. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR). 21p.

Data are presented on the content of ^{90}Sr and ^{137}Cs in the diet in the USSR during 1963 and 1964. Data on the quantities of these radioisotopes ingested by the population were obtained from direct radiochemical measurements of ^{90}Sr and ^{137}Cs in foods and water. Also studies were made of the diet structure of various population groups during each season based on the complete day-to-day menus of public dining establishments and children's institutions. It is shown that in the USSR 75% of the ^{90}Sr and 50% of the ^{137}Cs are ingested with bread products. The average amount ingested per person was 38 to 48 pCi of ^{90}Sr in 1963 and 58 to 72 pCi in 1964, while the ingested ^{137}Cs was 212 pCi in 1963 and 294 pCi in 1964. The ingestion of ^{90}Sr and ^{137}Cs by the rural population showed marked variations in different regions and when compared with urban populations. Milk was a source of ^{90}Sr and ^{137}Cs ingestion in some regions and peak concentrations of ^{90}Sr/kg were found in tea. Those persons using open reservoirs as their water supply ingested an additional 2pCi of ^{90}Sr daily. The ration in day nurseries and kindergartens in the cities contained approximately half the ^{90}Sr content of the adult diet. (C.H.)

4799 RECENT ADVANCES IN BIOLOGICAL PROTECTION AGAINST RADIATION LESIONS. Costachel, O.; Corneci, I.; Andrian, T. Rev. Sanit. Mil., 16: Special No., 339-64(1965). (In Rumanian).

Parameters of biological protection against radiation injuries reviewed include: mode of action; macromolecular protection with cell-free homogenates, plasma or serum components, and nucleic acids; and protection with viable cells emphasizing numbers of cells required. Data on radiation protection studies in rats, mice, guinea pigs, dogs, and monkeys are tabulated. Immunological problems in transplantation of bone marrow are discussed. (TSS)

4800 METHODS OF DETECTING INTERNAL RADIOCONTAMINATION WITH RADIOACTIVE IODINE AND SULFUR. Herscovici, H.; Furnica, Gh.; Racoveanu, N. Rev. Sanit. Mil., 16: Special No., 404-9(1965). (In Rumanian).

The reliability of detecting ^{131}I–NaI and ^{35}S was determined after oral administration or addition to human urine. Ion exchange resin uptake was an excellent method for analytical purposes. (TSS)

4801 EXPERIENCE OF THE NUCLEAR MEDICINE LABORATORY AT THE M.F.A. [ACRONYM NOT EXPLAINED] POLYCLINIC IN THE PROBLEM OF PROTECTION FROM THE DAMAGING EFFECT OF IONIZING RADIATION. Wasserstrom, V.; Herscovici, H. Rev. Sanit. Mil., 16: Special No., 398-403(1965). (In Rumanian).

Ideal dosimeter indicators (e.g. lithium fluoride), optimal methods for protection in radiation diagnosis, and treatment with various radioisotopes such as ^{131}I, ^{198}Au, ^{203}Hg, ^{51}Cr, and ^{60}Co are discussed. External decontamination using detergent and internal decontamination employing chelates are considered. (TSS)

4802 PRINCIPLES AND METHODS OF PROTECTION FROM RADIATION FOR PERSONNEL OF RADIOLOGIC LABORATORIES AND FOR PATIENTS DURING RADIOLOGIC PROCEDURES. Gurau, C. Rev. Sanit. Mil., 16: Special No., 393-8(1965). (In Rumanian).

Radiation protection of radiologists, technicians, assistants, and patients is discussed. Types of apparatus, skills necessary for persons operating the devices, standard operating procedures, and permissible deviations of protective devices such as shields are considered. (TSS)

4803 EXPERIMENTAL PROCEDURE FOR ELIMINATION OF RADIOACTIVE ISOTOPE IN ANIMALS CONTAMINATED ORALLY. Bergheanu, S.; Gheorghe, N.; Cavulea, O.; Plesca, I. Rev. Sanit. Mil., 16: Special No., 418(1965). (In Rumanian).

Activated charcoal in gum tragacanth administered by gavage had little effect on chromium-51, iodine-131, phosphorus-32, and calcium-45 uptake by lungs, liver, spleen, bone, kidneys, and intestines. However, the same treatment followed by a drastic purgative agent had pronounced favorable effects. (JPRS)

4804 DISTRIBUTION OF THE ABSORBED DOSE OF FAST NEUTRONS IN A HETEROGENEOUS PHANTOM. Bregadze, Yu. I.; Isaev, B. M. (Inst. of Biological Physics, Moscow). Radiobiologiya, 6: 308-11(1966). (In Russian).

In evaluating the effect of neutrons on biological systems, it is important to consider not only the mean tissue dose but also the different absorptive properties of different tissues such as bone, muscle, and fat. This is facilitated by a study of the absorption of neutrons in homogeneous models (phantoms) made of various substances (polyethylene, polystyrene, graphite), with particular attention to their C and H content. The change in absorption was determined with depth in a heterogeneous model made of layers of fat, muscle, and bone and subjected to x-irradiation or bombardment with fast neutrons. (ATD)

4805 DISTRIBUTION OF ABSORBED ENERGY IN DEPTH IN MATERIALS MADE OF LIGHT ATOMS AND IRRADIATED WITH ACCELERATED ELECTRONS HAVING ENERGIES OF 0.4 TO 1.2 MeV. Radzievskii, G. B.; Osanov, D. P. Radiobiologiya, 6: 298-307(1966). (In Russian).

In connection with the problems of dosimetry of accelerated electrons, the depth distributions of the absorbed energy in low-Z materials were determined for the geometry of an infinitely broad electron beam. Measurements were made of the relative dose distributions in a number of materials in the case of normal incidence of the electron beam with energies in the range 0.4 to 1.2 MeV. The partially contradictory data cited in the literature concerning the dose distributions in the case of normal incidence were refined. The relative dose distributions in the case of oblique incidence of the beam were measured for certain materials within the range of angles of incidence from zero (I) up to 60°. The disappearance of maxima on the dose curves when I is increased to $\sim 60°$ was detected, and an explanation was proposed for this phenomenon. The question of normalization of the relative dose distributions, i.e., of the determination of the absolute doses corresponding to a set magnitude of the electron beam on the sample, was considered. The proposed methods of normalization require a knowledge of the dose (Δ) or energy (p) coefficients of backscattering of the electrons. The coefficients Δ were estimated for certain low-Z materials and energies E_0 in the range 0.4 to 1.0 MeV. (auth)

4806 STUDIES ON ELIMINATION OF RADIOACTIVE ISOTOPE USING ION EXCHANGE RESIN IN ANIMALS ADMINISTERED THE RADIATION AGENT ORALLY. Gheorghe, N.; Bergheanu, S.; Plesca, I.; Furnica, Gh. Rev. Sanit. Mil., 16: Special No., 418-21(1965). (In Rumanian).

The effectiveness of ion exchange resins in eliminating ^{131}I-NaI was studied in 30 rats by measuring the amount of the isotope in each of 6 organs, 2, 24, 72, and 96 hours after administration. Results were excellent, provided that the resin was already in the intestines before the radioisotope arrived. (JPRS)

4807 RADIATION SOURCES AND LIGHTNING. **Lancet, 1: 1198-9(May 28, 1966).**

The possibility that ionization of air produced by radiotherapy devices, for example, ^{60}Co sources, may predispose toward lightning strikes is discussed in relation to a new type of lightning rod tipped with radioisotopes. The claim is made for these rods that the ionization produced by the source (usually of radium or americium) will enhance the conducting power of the surrounding air and therefore improve the effectiveness of the device. It has been calculated that the ionization produced by a typical commercial installation of this kind, at the distance of 100 m to which protection is claimed to extend, is less than 1% of that associated with the natural radiation background. It is observed that a kiloCurie source of ^{60}Co, as commonly used in radiotherapy, will give a much greater amount of ionization at 100 m, which introduces the possibility of a lightning hazard to radiotherapy departments. However, it is believed that no such hazard exists. The assertion that a lightning conductor can be made more effective by the addition of a radioactive source is unsupported by convincing experimental or statistical evidence. Moreover, there is reason to believe that the radioactive attachment will have no effect whatever. It is pointed out that hot gases escaping from a chimney are appreciably ionized, but hot and cold chimneys appear equally liable to lightning damage. The exhaust gases from an airplane are an even richer source of ions, but lightning damage to the exhaust system is very uncommon. A properly designed lightning conductor of the traditional Franklin type, with or without a radioactive pinnacle, is adequate for any building. It is suggested that there is no need for radiotherapists to shut off their machines during a thunderstorm. (BBB)

4808 PROBLEM OF ESTIMATING ADSORBED DOSES OF RADIOPHOSPHORUS INCORPORATED IN TISSUES. Pugachevskii, V. P. (Scientific-Research Inst. of Industrial Hygiene and Occupational Diseases, Kiev). Radiobiologiya, 6: 326-7(1966). (In Russian).

Assuming uniform distribution of ^{32}P at equilibrium in soft tissues, the absorbed dose to various soft tissues following inhalation may be estimated with an error of no more than 36%, a margin that satisfies the aims of dosimetry. The method was evaluated in experiments with female rats given $Na_2H^{32}PO_4$ in doses of 2 uCi/day. (H.G.D.)

4809 THERMOLUMINESCENCE DOSIMETRY IN FAST-NEUTRON PERSONNEL MONITORING, EMPLOYING BODY-MODERATION. Mejdahl, Vagn (Danish Atomic Energy Commission, Roskilde, Denmark). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/38, 16p. (CONF-660807–25). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

An investigation of a personnel monitoring system based on the body as the principal moderator is described. The body was simulated by a phantom made from water-filled lucite cylinders. Additional moderation was provided by small blocks of paraffin. The luminophors studied were Harshaw LiF (TLD-100 and TLD-600), and $Li_2B_4O_7$: Mn. The powder was sealed under an argon atmosphere in needle-shaped glass tubes, 12 mm long and with an inner diameter of 0.5 mm. The dosimeters were irradiated on the phantom with neutrons from a 10-Ci Am–Be source. The variation of the response with the dimensions of the paraffin blocks and with the orientation of the phantom in the neutron field was investigated. The glow-peak-height response of TLD-600 per Rem (2.68×10^7 m/cm^2) of fast neutrons was equal to the response produced by ^{60}Co γ-ray exposures ranging from 0.7 to 3.4 R, depending on the neutron-moderating conditions. When TLD-600 was replaced by TLD-100 and $Li_2B_4O_7$: Mn, the corresponding ^{60}Co γ-ray exposures required to give the same response as one Rem of fast neutrons were smaller by factors of 0.18 and 0.24 respectively. The effect of self-shielding of thermal neutrons on the response was demonstrated by a calculation of the relative fast-neutron to gamma response vs thickness of the phosphor layer. The calculation was normalized to fit experimental results. Since most critical organs are located near the midline of the body the possibility of relating dosimeter reading to midline dose equivalent is briefly discussed. (auth)

4810 SURVEY OF RADIATION DOSIMETRY IN THORIUM DIOXIDE CASES. Dudley, Robert A. (International Atomic Energy Agency, Vienna). 24p. (CONF-660422-2). ORAU. Gmelin, AED-CONF-66-178-2.

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York.

The objectives, problems, techniques, and results of radiation dosimetry as applied to persons containing Thorotrast are discussed. One objective is understanding of the effects occurring at primary Thorotrast deposits in the liver and spleen. A second objective is clarification of the effects of bone marrow irradiation; it is known that leukemia is caused by irradiation of marrow and by Thorotrast. A third objective is the study of doses to the lung which receives considerable irradiation through primary Thorotrast deposits and concentration of thoron. This condition has relevance to inhalation of radon which occurs in mines. A fourth objective is the investigation of skeletal doses since the skeleton is the critical organ for many internally deposited isotopes, especially radium-226. Problems in Thorotrast dosimetry are discussed. For example, administration of Thorotrast to the blood, kidney, and other organs gives different dose distributions to each; the colloid is deposited non-uniformly, giving a wide range of dose rates to different regions of the same organ. Measurements related to Thorotrast dosimetry are discussed. Three types of measurement can be performed on living Thorotrast cases: observations on gamma rays emerging from the body, studies of exhaled or excreted isotopes, and analyses of biopsy samples. A discussion of these is given. A table is given to show the approximate mean excretion of thorium-232, radium-228, actinium-228, thorium-228, radium-224 and lead-212. Metabolic studies of thorium series isotopes in man and animals are discussed. (H.L.W.)

4811 DETERMINATION OF DOSE EQUIVALENT OF MIXED RADIATION BY LET-DEPENDENT DETECTORS. Zielczynski, M. (Instytut Badan Jadrowych, Swierk, Poland). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-76/39, 16p. (In Russian). (CONF-660807-38). ORAU.

From Symposium on Neutron Monitoring for Radiological Protection, Vienna.

The requirements of detectors for determination of dose equivalent (DE) from mixed radiation are analyzed. The DE of radiation consisting of different kinds of particles with unknown energy distribution can be determined from the indications of a number of detectors having sensitivities which vary in different ways with the LET. Detector sensitivity means the ratio of the detector output signal to the absorbed dose. Even one detector can be regarded as a group of detectors, if it can produce several output signals or can work in various conditions. The sensitivity of each detector in a given LET interval can be determined by computation or by calibration in radiation fields of different and known LET. From the sensitivity matrix established one can determine the absorbed dose, dose equivalent and dose distribution with respect to the LET in any mixed radiation field. In the systems normally used in practice, the sensitivity of one detector is independent of the LET. This, however, is not a necessary requirement—it is sufficient that the sensitivities of the two detectors be two distinct linear functions of the QF. Therefore high-pressure recombination chambers, in which it may be impossible to achieve complete saturation, can be used as DE detectors. This is also true of ionization chambers with a liquid dielectric, and of scintillation, chemical and other systems in which there is a corresponding dependence of sensitivity on LET. Ways of analyzing the results of this general discussion are considered, with reference to certain actual detectors. The theory presented was used to develop new methods of measuring the DE of mixed radiation. (TSS)

4812 PROBE FOR THE CLINICAL DOSIMETRY OF ROENTGEN AND GAMMA RAYS. Dosse, Joachim (to Siemens and Halske Aktiengesellschaft). German Patent 1,220,529. July 7, 1966. Filed Mar. 18, 1953.

In a probe suited for being introduced into the human body (hypodermic needle, catheter) a semiconducting body is utilized having the the shape of a spherical cap and consisting of n- and p-type regions with a radiation sensitive barrier layer between them. The shape of the spherical cap is chosen in such a way that the directional dependence of the radiation sensitivity becomes uniform. (auth)

Medicine

4813 (AD-632702) APPLICATION OF 185 Mev PROTON BEAM TO EXPERIMENTAL CANCER THERAPY AND NEUROSURGERY. A Biophysical Study. Larsson, Borje (Uppsala Univ. (Sweden)). Mar. 1962. Contract AF 61(052)-183. 20p. CFSTI $1.00 cy, $0.50 mn.

There is reason to believe, even if surgical, chemical and immunologic methods will eventually replace radiation in such therapy, that the localized irradiation of tissues deep in the body will persist as an important therapeutic procedure for other reasons. The belief is based on the observation of the increasing number of therapeutic procedures in which ionizing radiation was suggested for various purposes, e.g. for influencing the function of the pituitary gland in cases of endocrine disorder, for destroying the function of cerebral fiber tracts or nuclei, as considered above, for destroying the defense of the body against foreign transplanted tissues, for stimulating the vascularization of the myocardium in cases of insufficient coronary circulation, and for oto-microsurgery. The results of the present study show that beams of charged heavy particles represent a versatile type of radiation that may be used to advantage in such studies of the effects of local irradiation as might be of value in the design of therapy. (STAR)

4814 (EUR-2477.f(Vol.2)) ETUDE EXPERIMENTALE DU TRAITEMENT DES RADIOLESIONS PAR LA PADUTINE-DEPOT (KALLICREINE). Rapport Annuel d'Activite du Octobre 1, 1964 au Avril 1, 1965. (Experimental Study of the Treatment of Radiation Injuries by Padutin (Kallicreine). Activity Report from October 1, 1964 to April 1, 1965). Mandel, P.; Mantz, J. M.; Delemen, M.; Gary, C.; Michaelidis, P.; Schmitt, C. (Strasbourg Univ. (France)); Rodesch, J.; Massart, A. (European Atomic Energy Community). July 1966. Contract 054-63-10 BIOF. 24p. Dep. mn.

The results of additional experiments carried out under the research contract confirmed the favorable effect of padutin (kallikrein) in the treatment of experimental radionecrosis in the rats and guinea-pigs. The study on the rabbit is now in progress. Various tests on the rat showed that padutin has an optimum effect. The optimum dose in the rat appears to be 5 BU. A preliminary study, in which the action of padutin is compared with another vasodilator, AET, revealed that only padutin was successful. The possible restorative and protective effect of padutin after total body irradiation (800 R) compared with other therapeutic substances is under study. The present state of the research suggests that padutin exercises a favorable influence as a restorative on the survival of irradiated animals. However, quantitative determinations of bone-marrow nucleic acids and cytological investigations, conducted concurrently, have also shown that padutin has a restorative action, which is particularly noticeable on the seventh day after irradiation. As regards RNA, this action would appear to be more pronounced in that of padutin than in that of AET. Where DNA is concerned, protection is of the same order of magnitude for both the substances used. It is planned to carry out a study on a possible association of several therapeutic substances. A biological study of padutin by means of paper chromatography and electrophoresis reveals the existence of only one compound and the absence of free amino-acids and small peptides. Analysis by the Stein and Moore method brings to light all the amino-acids the sulphurated compounds of which are in a proportion of 2%. An as yet unidentified constituent is now being analyzed. The favorable effect of padutin on cicatrization as observed in rodents is now being checked in the pig. The exploratory experiments carried out to date have been concerned mainly with the anesthesia process and determination of the optimum irradiation dose which produces stable x ray dermatitis. The results so far obtained show that the onset, development and seriousness of the lesions are more rapid and more marked than in the case of rodents irradiated with far heavier doses. (auth)

4815 (EUR-2477.f(Vol.3)) ETUDE EXPERIMENTALE DU TRAITEMENT DES RADIOLESIONS PAR LA PADUTINE-DEPOT (KALLICREINE). Rapport Annuel d'Activite du Avril 1, 1965 au Octobre 1, 1965. (Experimental Study of the Treatment of Radiation Injuries by Padutin (Kallicreine). Activity Report from April 1, 1965 to October 1, 1965). Mandel, P.; Mantz, J. M.; Delemen, M.; Michaelidis, P. (Strasbourg Univ. (France)); Rodesch, J.; Massart, A. (European Atomic Energy Community). July 1966. Contract 054-63-10 BIOF. 22p. Dep. mn.

Further experiments carried out on the rat show that following a treatment with kallicreine the cicatrization period for cutaneous radiolesions is considerably lower in the treated animals than in the controls. (60,000 R). The same phenomenon has been demonstrated with the guinea-pig and the rabbit (80,000 R). Experiments are at present in progress to corroborate these findings. Study of the optimum treatment conditions led to the following therapeutic doses: 5 BU for the rat, 10 BU for the guinea-pig, and 20 BU for the rabbit. The best time to begin the treatment is the clear ulceration stage, i.e., 3rd week after irradiation for the rat and the guinea-pig, and 4th or 5th week for the rabbit. Kallicreine administered as a preventive injection after whole-body irradiation (800 R) appears to have no effect on the survival rate of the animals. However, quantitative determinations of nucleic acids and a cytological study of the marrow of a bone system show a protective effect which is particularly marked at about the 7th day after irradiation. From the recovery angle (treatment after whole-body irradiation at 800 R) it is observed that the life of the animals is considerably prolonged, particularly by the repeated intraperitoneal administration of kallicreine. Quantitative determinations of bone-marrow nucleic acids permit the inference of a regeneration of the medullary cells which is especially active from the 4th day after irradiation. A cytological exploration on the same system is at present in progress. Several experiments have been carried out on the pig, whose skin morphology is similar to that of man. Radionecroses induced by a local irradiation of 45,000 R and treated with two different doses of Kallicreine (20 and 40 BU) show (particularly in the second case) a much more rapid cicatrization than in the controls. An experiment is at present in progress to corroborate these findings. (auth)

4816 A NEW TECHNIC IN RADIOISOTOPE SCINTILLATION SCANNING TO IMPROVE DEPTH RESOLUTION. Skolnick, M. Leon (Presbyterian Hospital, New York). Radiology, 87: 1108-15(Dec. 1966).

A new technique of scintillation scanning is described in which individual radioactive sources at different depths within a phantom are discretely resolved. The technique is applicable to conventional rectilinear scanners if used in conjunction with a low-energy focusing gamma-ray collimator and ^{99m}Tc. It appears to have potential clinical application in scanning of the thyroid and brain. (auth)

4817 STATUS OF RADIATION THERAPY OF THE RENAL REGION USING DIVIDED FIELDS. Del Vecchio, E. (Univ., Naples). Radiobiol. Radioterap. Fis. Med., 21: 260-73(July-Aug. 1966). (In Italian).

Divided field radiotherapy of the kidney region is described. Differences in dose distribution with conventional therapy and ^{60}Co are demonstrated, and the importance of wedge filters in obtaining better dose distribution and in sparing the surrounding healthy tissue is emphasized. (H.G.D.)

4818 MORPHOLOGICAL CHANGES OF MELANOBLASTOMAS AFTER RADIOTHERAPY. Golbert, Z. V.; Papliyan, N. P. (Herzen Research Oncological Inst., Moscow). Vop. Onkol., 12: No. 10, 44-50(1966). (In Russian).

Difficulties of clinical and morphological diagnosis of melanoblastomas, especially after preoperative radiotherapy, are emphasized. Data are presented on morphological characteristics of melanoblastomas in 78 patients after radiotherapy. In 52 patients diagnosis of the melanoblastoma was confirmed morphologically after preoperative radiotherapy. The tumor was not revealed microscopically after radiotherapy in 10 patients with clinically unquestionable diagnosis of the melanoblastoma. Microscopic changes found in the tissues permitted the assumption that a complete resorption of the tumor occurred. In 11 patients microscopic examination of the removed specimens revealed a picture characteristic for nevus without malignization. In 5 patients clinical diagnosis of melanoblastoma was not confirmed. (auth)

4819 QUANTITATIVE STUDIES ON THE RELATION BETWEEN THE RADIATION DOSE AND BIOLOGIC REACTIONS THERETO, AND APPLICATION WITH EVALUATION OF RADIOPROTECTIVE COMPOUNDS. Tang, Chung-ming; Tu, Teh-lin; Wu, Teh-chong; Han, Jung-hsin; Li, Han-fang; Lu, Pai-chuan. Rev. Sanit. Mil., 16: Special No., 371-84(1965). (In Rumanian).

Studies were conducted on 140 dogs irradiated with ^{60}Co (200 to 450 R). Mortality, dose relationship, mean survival times, effects on leukocytes (neutrophils, lymphocytes, and eosinophils), platelets, and hemoglobin, the course of the fever reaction, and the protective effects of AET and cysteine were investigated. (TSAT)

4820 SOME ASPECTS OF PROTECTIVE ACTIVITY AGAINST RADIATION OF SOME SULFUR-CONTAINING PREPARATIONS. Dkarakian, T. K. Rev. Sanit. Mil., 16: Special No., 365-71(1965). (In Rumanian).

Animal studies with cystamine and aminoethylisothiuronium bromide showed that distribution of ^{35}S-marked radioprotectants in the spleen and liver cells in rats penetrated into nuclei, mitochondria, and hyaloplasm within 5 to 15 minutes after injection. Irradiation with 600 R changed somewhat the distribution in cellular fractions. Cystamine tended to counteract irradiation-induced depression of oxidative phosphorylation in the spleen; it also protected lymphoid cells from radiation effects and restored radiation-depressed immunization effectiveness of tetanus vaccination. (JPRS)

4821 PREVENTION AND TREATMENT OF RADIATION SICKNESS. NEW DATA ON THE MECHANISM OF CHEMICAL PROTECTION AGAINST RADIATION SICKNESS. Nicolau, Cl. Rev. Sanit. Mil., 16: Special No., 333-9(1965). (In Rumanian).

Studies with AET, sodium diethyldithiocarbamate, N-acetyl homocysteine thiolactone, and α, α-diphenyl-beta-picrylhydrazil are reviewed. Biochemical methods of protection and of determining the degree of protection and the mode of action of the protective agent are discussed. (JPRS)

4822 EFFECT OF ADMINISTRATION OF IMMUNE HOMOLOGOUS ANTITISSULAR SERUM IN IRRADIATED MICE. Correni, E.; Mihaescu-Nigrim, Maria; Benes, S.; Buzarnescu, G. Rev. Sanit. Mil., 16: Special No., 481-7(1965). (In Rumanian).

In mice, injection of homologous immune sera of spleen or liver homologous tissue antibodies tended to exert a protective effect against injuries from subsequent radiation as to onset of radiation sickness and total mortality. (TSS)

4823 EVOLUTION OF CARDIAC LESIONS IN ACUTE RADIATION SICKNESS. Niculescu, Gh.; Strimbeanu, I.; Giurgiu, T.; Cioba, Gh.; Danciuloiu, Al.; Safta, T. Rev. Sanit. Mil., 16: Special No., 460-4(1965). (In Rumanian).

Fifteen dogs were given 450 R doses of whole-body irradiation 48 hrs prior to cardiac suture. Histopathological studies and EKG tests were made. Results indicated that acute radiation sickness interferes little, if any, with resilience of cardiac tissue and functional capacity for recovery. (TSS)

4824 EFFECT OF SOME SUBCELLULAR THYMUS TISSUE FRACTIONS IN RADIATION SICKNESS IN MICE. Cavulea, O.; Gheorghe, N.; Gaspar, A.; Plesca, I.; Bergheanu, S.; Popescu, Gh.; Milea, T. Rev. Sanit. Mil., 16: Special No., 414-17(1965). (In Rumanian).

Mitigation of radiation sickness in mice was studied in animals given injections of mitochondria and nuclei. A single administration of mitochondria was more effective than repetitive treatments, but administration of nuclei only was superior. (TSS)

4825 INFLUENCE OF CYSTAMINE AND S, β-AMINOETHYLISOTHIURONIUM ON DESOXYRIBONUCLEASE-II ACTIVITY IN RADIOSENSITIVE ORGANS OF RATS IRRADIATED WITH THE DOSES OF 350 AND 100 R. Libikova, N. I. (Kirov Military-Medical Academy, Leningrad). Radiobiologiya, 6: 166-9(1966). (In Russian).

The effects of cystamine and AET on the activity of DNA-ase II were studied in the spleen and thymus of rats given x-ray doses of 100 and 350 R. In irradiated controls DNA-ase II activity rose sharply one day post-irradiation after which it declined until the seventh day at which time activity was again normal. Both AET and cystamine depressed the radioinduced increase in DNA-ase II activity in spleen and thymus. The enzyme activity was not affected in unirradiated controls administered the radioprotective preparations. (H.G.D.)

4826 CARDIAC BLOOD POOL SCANNING WITH ^{99m}Tc-PERTECHNETATE-LABELED ALBUMIN. Webber, M. M.; Tobin, P. L.; Bennett, L. R. (Center for the Health Sciences, Los Angeles). Radiology, 87: 867-71(Nov. 1966).

The ^{99m}Tc-serum albumin method for scanning cardiac blood pool is compared to methods using ^{99m}Tc-pertechnetate. Technetium-labeled-albumin heart scans define the detail of the cardiac silhouette more clearly than pertechnetate scans. Pericardial effusion, pericardial tumor, ventricular aneurysm, and aortic aneurysm are well delineated by the tracer. A clear area surrounding the cardiac blood pool chambers and disparity between the size of the cardiac blood pool on the scan with the cardiac size on the comparable roentgenogram are the only criteria that apply to diagnosis of pericardial effusion or pericardial tumor. Separation of the cardiac blood pool from the hepatic blood pool is normal. The dose in rads to the patient from ^{99m}Tc is minimal and much less than that received from more conventional techniques. The achievement of satisfactory pictorial representation of the cardiovascular blood pools requires careful attention to gathering sufficient number counts to ensure that statistical variation is not limiting the detail. Speed of performing the procedure must be sacrificed for quality in the picture. Cardiovascular scanning is undoubtedly useful in the diagnosis and confirmation of many conditions which would otherwise require roentgenographic contrast methods. (H.G.D.)

4827 TOTAL-SKIN ELECTRON-BEAM THERAPY OF LYMPHOMA CUTIS AND GENERALIZED PSORIASIS: CLINICAL EXPERIENCES AND ADVERSE REACTIONS. Grollman, J. H. Jr.; Bierman, Stanley M.; Ottoman, Richard E.; Morgan, J. E.; Horns, John (Univ. of California, Los Angeles). Radiology, 87: 908-15(Nov. 1966).

Total-skin electron-beam therapy with energies of approximately 3 to 6 MeV was employed in the treatment of 26 patients with lymphoma cutis and 8 with generalized and exfoliative psoriasis. Seven patients with exfoliative erythroderma improved with therapy, having a prompt decrease in pruritus and involution of the scaling erythroderma. Fifteen of 16 patients with mycosis fungoides were either completely controlled or received satisfactory palliation by electron-beam therapy, although higher doses were required than in treating exfoliative erythroderma. Three patients with lymphosarcoma died before sufficient electron beam therapy could be given. The therapeutic response in 8 patients with generalized and exfoliative psoriasis, although initially good, resulted in temporary remission of symptoms only. Complications of total-skin electron-beam therapy involved the hematopoietic, cutaneous, and subcutaneous tissues. Bone-marrow depression developed in 9 patients as a result of the contamination of the electron beam by x ray that originated within the collimating system of the linear accelerator utilized. Subsequently, the x-ray contamination was reduced to an acceptable level. Adverse cutaneous reactions were telangiectasis, poikiloderma, alopecia, onycholysis, and xerosis. In a patient with mycosis fungoides, generalized incapacitating subcutaneous fibrosis developed subsequent to intensive total-skin electron-beam therapy. Use of the electron beam with energies greater than 3 MeV resulted in an increase in the electron dose delivered to the subcutaneous tissues in excess of that delivered to the skin. (auth)

4828 INFLUENCE OF SPECIFIC POLYSACCHARIDES OF TYPHOID BACTERIA AND PROTEINS, THE STRUCTURE OF WHICH IS PARTIALLY CHANGED BY ACIDIC HYDROLYSIS, ACETYLATION, AND OXIDATION, ON RADIORESISTANCE OF MICE. Duplischeva, A. P.; Ivanov, K. K.; Sinilova, I. G. (Inst. of Epidemology and Microbiology, Moscow). Radiobiologiya, 6: 318-21(1966). (In Russian).

Specific polysaccharides from typhoid fever bacteria and Proteus, when administered intraperitoneally 24 hours before irradiation, resulted in survival of about 31% of the mice given 750 R γ doses. Alcohol fractionation of the specific polysaccharides did not lead to the isolation of fractions more active in protective properties. Hydrolysis or acetylation of the specific polysaccharides with 1$\underline{N}$ acetic acid sharply reduced the radioprotective properties. Oxidation of the specific polysaccharides with iodic acid did not cause any changes in their protective properties. (H.G.D.)

4829 FORMATION OF ANTIBODIES IN RATS RECEIVING INJECTIONS OF VITAMIN K3 AND EXPOSED TO X-IRRADIATION. Benes, S.; Mihaescu-Nigrim, Maria; Dobrescu, V.; Ciobanescu, Mariana. Rev. Sanit. Mil., 16: Special No., 474-81(1965). (In Rumanian).

Preliminary studies on rats administered vitamin K_3 15 minutes before x-irradiation with 250 R showed that mortality was 55% in comparison with 19% in irradiated rats not having received the vitamin. However, in a later more comprehensive study results on the effect of K_3 on mortality and immunogenicity in irradiated rats were relatively uncertain despite statistical treatment. (JPRS)

4830 SHORT-TERM INFLUENCE OF URETHAN AND X RAYS EMPLOYED ALONE AND IN COMBINATION ON THE APPEARANCE OF PULMONARY ADENOMAS AND LEUKEMIAS IN VARIOUS STRAINS OF MICE. Chouroulinkov, I.; Riviere, M. R.; Guerin, M. (Institut de la Recherche sur le Cancer, Villejuif, France). Bull. Ass. Franc. Etude Cancer, 52: 331-48(Oct.-Dec. 1965).

The carcinogenic and leukemogenic action of urethan and of whole-body irradiation, either alone or combined, on the short-term appearance (i.e., up to 6 months after the treatment) of malignancy was examined in five mouse strains (C57Bl/6, AKR, Swiss, IC, and XLII). Irradiation was applied in a single dose of 300 R and the urethan was given intraperitoneally in a single dose of 1 mg/g body weight. The strains differ widely from each other in their response to these treatments. For example, urethan induced pulmonary adenomas in each strain studied except strain XLII. In Swiss mice, x rays seemed to reduce the appearance of the pulmonary tumors. The combination of x rays and urethan also reduced the percentage of pulmonary adenomas. As for leukemia, an increase in its incidence after x irradiation was noted in strain IC. The combination of urethan and irradiation seemed to reduce somewhat the frequency of lymphomatosis. In strain AKR, x irradiation alone increased the leukemia rate. The combination of irradiation and urethan showed no inhibition effect; x rays seem to act independently of urethan in leukemogenesis. The results illustrate the divergent effects of neoplastic agents in different strains of the same species. (BBB)

4831 RADIOTHERAPY FOR TRANSITIONAL-CELL CARCINOMA OF THE URINARY BLADDER WITH ^{60}Co. del Regato, J. A.; Chahbazian, C. M. (Penrose Cancer Hospital, Colorado Springs, Colo.). Radiology, 87: 1053-7(Dec. 1966).

Transitional-cell carcinoma of the urinary bladder is curable by radiations in a high proportion of cases. Cobalt-60 teletherapy permits an extensive and intensive irradiation of the potential tumor area, yielding complete destruction of rather advanced tumors. A minimum tumor dose of 6,600 R can be delivered with ease in thirty-five to forty-two days through an anterior and two posterolateral pelvic fields without any serious reactions or untoward effects. In a series of 30 patients treated, 12 (40 per cent) survived five years without evidence of recurrence or metastases. Six additional patients died without histologic evidence of residual tumor in the bladder, bringing the total of healed carcinomas in the bladder to 60 per cent. Two out of 4 women treated survived. Seven of 14 patients with differentiated carcinoma and 5 of 16 with undifferentiated neoplasma are among the survivors. The bladder capacity and function of the surviving patients became normal in almost all instances. Small bowel obstruction, possibly due to the effects of irradiation, occurred in 2 cases. There were no necrotic or other complications of the skin or large bowel, and no fistulas developed. (auth)

4832 A STUDY OF THE PROTECTIVE EFFECT OF CYSTAMINE ON HEMOPOIESIS IN IRRADIATED RATS. Tkadlecek, L.; Iurascova, V.; Dostal, M.; Zahvei, I. Rev. Sanit. Mil., 16: Special No., 384-9(1965). (In Rumanian).

Studies were conducted on rats irradiated with 470, 575, 680, and 780 R of ^{60}Co, 15 minutes after 120 mg/Kg injections of cystamine intraperitoneally. The drug reduced the adverse effects of radiation exposure on the number of residual hemopoiesis colonies in the spleen. (TSS)

4833 PRELIMINARY STUDY OF RADIOPROTECTION OF MICE WITH NUCLEIC ACIDS FROM HOMOLOGOUS BONE MARROW. Popescu, Gh.; Popa, Rodica; Benes, S.; Gheorghe, N. Rev. Sanit. Mil., 16: Special No., 409-14(1965). (In Rumanian).

Mice were injected intraperitoneally with DNA and RNA from homologous bone marrow and irradiated with 700 R 10 or 30 minutes later. Such treatment sharply reduced the mortality and prolonged life in those mice that did survive. (JPRS)

4834 RADIOPROTECTIVE ACTION OF MARROW TRANSPLANTED BEFORE IRRADIATION. Zhabina, M. I.; Petrov, R. V. Radiobiologiya, 6: 329-30(1966). (In Russian).

Isogenic bone marrow was transplanted into mice one to three hrs before exposure to 650 or 700 R doses of γ rays. Sixty-one percent of the irradiated controls survived the 650 R dose compared to 5% survival at the 700 R dose. Bone marrow transplantations prior to irradiation increased survival to 82% in the 600 R group and 32% in the 700 R group. The radioprotective effect is explained by the fact that transplanted cells, found in the blood stream or at injection sites, are less radiosensitive immediately following injection and are therefore more likely to recover from radiation injury. In essence transplantation produces a lower index of radiosensitive cells. (H.G.D.)

4835 POST-IRRADIATION INDUCED SENSITIZATION OF INHIBITION OF OXIDATIVE PHOSPHORYLATION BY IODOACETAMIDE. Fritz-Niggli, H. (Univ., Zurich). Experientia, 22: 666-7(1966).

Addition of iodoacetamide during x irradiation of isolated liver mitochondria from rats increased the radioinduced inhibition of oxidative phosphorylation. Subsequent treatment permitted a latent radiation injury to become evident, which probably consisted of a latent production of ATPase. Possibly the known radiosensitizing effect of iodoacetamide on inhibition of ATP production in organisms and cells depends on an interference with recovery processes. (TSS)

4836 RADIOBIOLOGICAL BASIS OF RADIOTHERAPY. Lajtha, Laszlo G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nowotwory, 16: 209-20(1966). (In Polish).

In this article the nature of exponential growth is defined and a kinetic model of tumor cell population is presented along with possible changes in the rate of tumor growth resulting from radiotherapy. The way in which mammalian cells can be grown in vitro as clones is briefly characterized and the use made of this method for measurements of the capacity for growth of irradiated cell populations is described. After presentation of the dose-response curves for the reproductive integrity of such cells, conclusions which may be drawn from them for radiotherapy are fully discussed: first, the size of tumor as an important factor in its curability; secondly, cell recovery phenomena and their implications for dose fractionation. Next, the oxygen effect is mentioned and amply illustrated with examples related to clinical experience. The problem of the time-spacing of fractions is considered. Finally, some important characteristics of tumors bearing on their radiosensitivity are listed, namely, the proportion of anoxic cells, the percentage of growing cells, the rate of removal of sterilized cells, the rate of growth of surviving cells, and variations in the survival curves. (auth)

4837 GENETIC AND SOMATIC DAMAGE DUE TO IONIZING RADIATION AND RESPONSIBILITY OF THE RADIOLOGIST. Papagni, Leonardo (Ospedale Maggiore, Milan). Minerva Med., 56: 1331-8(Apr. 21, 1965). (In Italian).

Early and late injuries induced by ionizing radiations in various types of cells are reviewed in relation to their avoidance during radiologic practice. Studies of radiocarcinogenesis based on clinical data indicate that 10 to 30% of cases of radiodermatitis do develop cutaneous epitheliomas after a long latent period (~33 yr on the average). Thyroid cancer is known to follow radiotherapy to the neck region of children after relatively low doses (500 to 800 rad). The latent period in this instance is shorter, about 8 yr. Leukemogenic action of radiation as well as the nonneoplastic hematologic changes it causes are also considered. Reduced fertility may follow gonadal irradiation at moderate doses; sterility may be transient at doses of ~250 rad or permanent above 500 rad. Responsibilities of the radiologist in treating or examining pregnant women are defined. Fetal injury in the first trimester of pregnancy may result from as little as 50 rad. Radiation-induced genetic effects manifested in subsequent generations are also considered, and estimation of the mutation rate doubling dose is discussed. Means whereby radiologists can reduce the population exposure from medical sources are listed. (BBB)

4838 PRELIMINARY RESULTS OF INTRALYMPHATIC RADIOTHERAPY IN HODGKIN'S DISEASE. **Di Pietro, Sergio; Uslenghi, Carlo (Istituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 51: 113-29(Mar.-Apr. 1965). (In Italian).**

The use of a new method employing a radioactive contrast agent to irradiate lymph nodes affected by Hodgkin's disease is reported. Lipiodol F labeled with ^{131}I was injected intralymphatically. The diagnostic findings and the therapeutic results obtained with its introduction into the lymphatic vessels of the dorsum of the foot in 36 patients with involvement of the retroperitoneal lymph nodes are presented. This method of intralymphatic radiotherapy is both diagnostic and therapeutic because the contrast medium opacifies the lymph nodes, simultaneously causing irradiation. A considerable decrease in size of the involved lymph nodes was observed. The maximum effect was obtained 1 or 2 months after the treatment and was directly proportional to the radioactivity of the introduced medium and to the degree of opacification of the lymph nodes and inversely proportional to their volume. A marked and generally prompt remission of the general symptomatology was obtained. The improvement lasted an average of 8 months. (BBB)

4839 INTENSIFICATION OF ANTITUMOR EFFECT OF X-RAYS BY MEANS OF DIRECT ELECTRIC CURRENT. Balmukhanov, S. B.; Azhigaliev, N. A. (Kazakh Scientific-Research Inst. of Oncology and Radiology, Alma-Ata, USSR). Radiobiologiya, 6: 312-14(1966). (In Russian).

A weak direct electric current was applied to transplanted tumors (Walker's carcinosarcoma, sarcoma-45, alveolar cancer of the liver RS-1, or Pliss' lymphosarcoma) in rats prior to x-irradiation of the transplant site. The electric current exerted no harmful influence on the animal and inhibited growth of the tumor transplants. However, the weak electric current when applied in conjunction with x rays intensified the antitumoral effect of the radiation synergistically by radiosensitization of the tumor. (H.G.D.)

4840 OBSERVATIONS ON THE EFFECT OF THE TOTAL THYMUS EXTRACT IN THE TREATMENT OF RADIATION SICKNESS IN MICE. Cavulea, O.; Gheorghe, N.; Popescu, Gh.; Plesca, I.; Bergheanu, S.; Milea, T. Rev. Sanit. Mil., 16: Special No., 417(1965). (In Rumanian).

Thymus extract had little effect on the $LD_{95/30}$ in mice, but when penicillin and streptomycin were added, a favorable effect was definitely noted. (JPRS)

4841 ACTIVITY OF 2-METHYL-1, 4-NAPHTHOQUINONE SODIUM BISULFITE (VITAMIN K3) ON SOME REDOX ENZYMES. Nicolau, Cl.; Tomas, E.; Olinescu, R.; Christea, Al.; Constantinescu, Rodica; Stroescu, Eugenia. Rev. Sanit. Mil., 16: Special No., 389-93(1965). (In Rumanian).

In vitro studies were made to pinpoint the mode of radiosensitization of vitamin K_3 in ceruloplasmin, catalase, peroxidase, d-amino-acidoxidases. Results indicate that vitamin K_3 effects inhibition or potentiation of the enzymatic activities, depending on its concentration. This is probably the mode of action of vitamin K_3 as radiosensitizer. (JPRS)

4842 EVALUATION OF A BARRIER CREAM AS A SUBSTITUTE FOR CONVENTIONAL PROTECTIVE CLOTHING. Wallis, L. R. 6p. (CONF-660621-21). ORAU. Gmelin, AED-CONF-66-193-14.

From Health Physics Society, 11th Annual Meeting, Houston, Tex.

Use of barrier creams as a substitute for conventional protective clothing at the Hanford nuclear complex is discussed. The cream was tested at a variety of jobs at a reactor site ranging from thermocouple repair to valve repair. Contamination did not adhere to the cream as readily as the skin or gloves and in all cases was easily removed by washing the hands with soap and water. During a period roughly approximating the period in which the cream was in use, there were no hand injuries. (H.G.D.)

Radiation Effects on Animals

Refer also to abstracts 4667 and 4776.

4843 (TID-3097) BIOLOGICAL EFFECTS OF IONIZING RADIATION. **An Annotated Bibliography Covering the Years 1898–1957. Ingram, Marylou (comp.) (Rochester Univ., N. Y. Atomic Energy Project). Dec. 1966. Contract AT(30-1)-875. 1196p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.**

All aspects of the biological effects of ionizing radiation are included in the 12,726 references to published and report literature in this bibliography. Abstracts are included for most references. The index is issued as a separate volume. (H.L.W.)

4844 FAT-ABSORPTION ANALYSIS IN EXPERIMENTAL ANIMALS SHOWING THE RADIATION SYNDROME. **Nagy, Eva J.; Elekes, Istvan (Medical Univ., Budapest. Medico-Radiological Research Group, Budapest). Radiology, 87: 922-7 (Nov. 1966).**

Using ^{131}I–triolein, the extent of intestinal fat absorption changes in rats under different conditions of irradiation and the extent that these changes were compensated with sulfhydryl compounds administered before irradiation were studied. After whole-body irradiation with 650 R, considerable decrease took place in the rate of gastric evacuation and also in the degree of fat absorption. Histological examinations showed signs of acute inflammation in the ileum; the epithelium was detached; and there was no secretion. A certain depression of absorption was noted even under N-(2-mercaptoethyl) glycine (B-1490) protection, but B-1490 reduced the degree of radiation injury by some 40 per cent, without affecting the process of recruitment. (H.G.D.)

4845 TEMPORAL DISTRIBUTION OF DEATH RATE OF IRRADIATED ANIMALS. Kulinskii, V. I. (Post Graduate Medical Inst., Kharkov). Radiobiologiya, 6: 264-7(1966). (In Russian).

Three methods for quantitative analysis of the death rates of irradiated animals are considered. Theoretical survival curves were compared to empirical distribution data; logarithmic transformation of time was applied to distribution of death rate; and the increase in the probit of the death rate with time was calculated. (H.G.D.)

4846 ON THE RATE OF THE DEVELOPMENT OF SALMON SALAR L ROE IN WATER CONTAMINATED BY ^{90}Sr + ^{90}Y. Neustroev, G. V.; Podymahin, V. N. (Polar Scientific-Research Inst. of Fishing and Oceanography, Murmansk, USSR). Radiobiologiya, 6: 321-3(1966). (In Russian).

Development of salmon roe in aquaria contaminated with equilibrated ^{90}Sr–^{90}Y (10^{-6} Ci/l or 10^{-8} Ci/l) was compared with that of roe in uncontaminated aquaria. The development of roe was more rapid in the contaminated aquaria than in the controls, with the exception of the period from the appearance of pectoral fins to the beginning of pigmentation. Further, mortality and incidence of the deformities of roe in the radioactive environment did not exceed the same indices in roe and larvae from control aquaria. Rates of development and hatching of larvae were comparable at both radioisotope concentrations. However, mortality and number of deformities were higher in aquaria with higher levels of radioactivity. (H.G.D.)

4847 FUNCTION OF RAT THYROID GLAND DURING REPEATED IRRADIATION AND MERCAMINE INJECTION. Lomonos, P. I.; Pivanova, P. S. (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 6: 246-9(1966). (In Russian).

After x-irradiation of rats at a dose of 800 R, a decrease in the thyroid function is observed. The nature of the curve of absorption and elimination of radioactive iodine is thereby changed, with a shift of the absorption max to a later period after the injection of iodine in comparison with nonirradiated animals. In the case of repeated irradiation at a dose of 800 R, 14 days after a preliminary irradiation at a dose of 67 R, the absorption of radioactive iodine by the thyroid decreases even more. In the case of preliminary irradiation at a dose of 200 R, the absorption of iodine by the gland exceeds the level observed in animals irradiated once. Mercamine, administered to nonirradiated animals and before a single irradiation at a dose of 800 R, leads to a decrease in the thyroid function; however, the nature of the curve of the absorption of radioactive iodine is unchanged. The administration of mercamine before repeated irradiation at a dose of 800 R, after preliminary irradiation at a dose of 67 R, leads to a sharp increase in the thyroid function in comparison with the control repeatedly irradiated animals, without the administration of mercamine. In the case of preliminary irradiation at a dose of 200 R, the thyroid function is sharply inhibited in comparison with the control. (auth)

4848 EFFECT OF SOME CURARIZING SUBSTANCES ON THE CONDITIONS OF RADIATION SICKNESS. Giurgiu, T.; Safta, T.; Ionescu, P. Rev. Sanit. Mil., 16: Special No., 505 (1965). (In Rumanian).

In rabbits irradiated with 400 R, dextro-tubocurarine hydrochloride is a weaker muscular relaxant than in non-irradiated controls; gallamine did not change in its effect; succinylcholine was considerably potentiated and prolonged. Effects are probably due to the anticholinesterase effect of ionizing radiation. (JPRS)

4849 EXPERIMENTAL INFECTIONS IN RATS RECEIVING INJECTIONS OF VITAMIN K3 AND EXPOSED TO X-IRRADIATION. Mihaescu-Nigrim, Maria; Benes, S.; Andreuta, Irina; Dobrescu, V.; Ciobanescu, Mariana. Rev. Sanit. Mil., 16: Special No., 490-1 (1965). (In Rumanian).

In rats administered 100 mg/Kg of vitamin K_3, irradiated with

250 R, and inoculated with *Salmonella typhosa* vitamin K_3 did not increase either susceptibility to mortality from radiation or to virulence of the Salmonella. (JPRS)

4850 COMPARATIVE PHYSIOLOGICAL INVESTIGATIONS OF FUNCTIONAL STATE OF HEART SYMPATHETIC INNERVATION BY IRRADIATION. Maiorova, N. F. (Inst. of Experimental Medicine, Academy of Sciences, USSR. Central Scientific-Research Inst. of Roentgen-Radiology, Leningrad). Radiobiologiya, 6: 241-5(1966). (In Russian).

The tone of the coronary sympathetic centers (according to the change in the heart beat frequency in percent of the initial level to the injection of dihydroergotamine) is changed 30 min after x-irradiation of animals with different balance of inhibitory and stimulatory influences upon the heart (cats, rabbits, dogs). The maximum changes in the tone were observed in all species of animals one day after the action of ionizing radiation. The dynamics and nature of the changes differed in different species of animals: in dogs and rabbits, a decrease in the tone was observed during the first three days after irradiation, and in cats an increase. (auth)

4851 STUDIES ON THE PHARMACODYNAMIC ACTION OF SOME AUTONOMIC SUBSTANCES IN THE IRRADIATED BODY. Giurgiu, T.; Safta, T.; Ionescu, P. Rev. Sanit. Mil., 16: Special No., 498-504(1965). (In Rumanian).

The effects of norepinephrine and phenergan were studied in irradiated (500 R) dogs and rabbits. Initial reactions to both drugs were intensified by irradiation, but response to phenergan declined to levels less than that of nonirradiated controls in later phases of radiation sickness. Results are explained on the basis of a disruption in the autonomic nervous system. (TSS)

4852 PLEURAL REACTION AND LOCAL DIFFUSION OF PENICILLIN IN IRRADIATED MICE. Nestorescu, N.; Strati, I.; Macarie, O. Rev. Sanit. Mil., 16: Special No., 422-5(1965). (In Rumanian).

The effects of 300 R irradiation on turpentine pleurisy were investigated in rats. Penicillin administration was followed by higher concentration in the pleural fluid in irradiated than in control rats. (JPRS)

4853 ACTION OF IONIZING RADIATION ON THE NONSPECIFIC IMMUNITY LEVEL OF SUBJECTS WITH MALIGNANT UTERINE NEOPLASMS. Vatteroni, M. (Univ., Rome). Quad. Clin. Obstet. Ginecol., 19: 216-24(Apr. 1964). (In Italian).

The effect of ionizing radiation on nonspecific components of the body defense system, such as properdin and lysozyme, is reviewed. Clinical studies were made on women undergoing radiotherapy for uterine cancer. Five cases of adenocarcinoma of the body of the uterus and 15 cases of cervical carcinoma in stages II and III were studied. Serum properdin levels were determined in these patients before, immediately after, and one month after radiotherapy which entailed tumor doses averaging 6000 R. In general, the initial values of properdin varied in accordance with the severity of the malignancy and degree of metastases. In all 20 cases serum properdin levels were lower immediately after than before irradiation. A partial return toward initial values was noted one month postirradiation. Higher initial and final levels were found in the five patients with corpus uteri carcinoma than in those with cervical cancer. The depletion of this nonspecific defense factor in blood after irradiation is further evidence of the impairment of immunity caused by ionizing radiation. (BBB)

4854 SYSTEMIC ARTERIAL CIRCULATION AND RENAL CIRCULATION DURING IRRADIATION OF LUNG TUMOR CARRIERS. Cinotti, G. A.; Falcetti, E.; Luzietti, L.; Paleani-Vettori, P. G. (Univ., Rome). Nunt. Radiol., 31: 1383-91(Dec. 1965). (In Italian).

In a group of lung tumor patients, simultaneous changes of the systemic arterial circulation, the renal plasmatic flow, and the glomerular filtration were observed in the course of the first exposure to radiation. The statistical analysis of the observed changes suggested that the irradiation really influenced the development of the observed phenomena. It is concluded that a volume decrease of the extracellular water space underlies the observed changes at the level of the greater circulation and of the kidney, due to the development of hypovolemia accompanied by either humoral or nervous responses. (H.G.D.)

4855 INVESTIGATION OF LOCAL AND REMOTE IRRADIATION INFLUENCES ON PROLIFERATIVE ACTIVITY OF MARROW CELLS. Yanushevskaya, M. I.; Barakina, N. F. (Severtsov Inst. of Animal Morphology, Moscow). Radiobiologiya, 6: 237-40(1966). (In Russian).

The mitotic activity of bone marrow cells was studied in mice administered 200, 400, 700, or 1000 R whole-body doses of x rays, in animals in which a hind limb was shielded during x-ray exposure (700 R), and in animals in which the excised small intestine was irradiated (700 and 3000 R). Inhibition of the mitotic activity of the marrow cells exhibited a direct dependence upon the radiation dose (within the dose range 200 to 1000 R). Long-term effects of irradiation upon the proliferative activity of the marrow cells were transitory, depending upon the radiation dose and the dimensions of the exposed portion of the body. No tissue specificity was evident. The mitotic activity of irradiated marrow cells was rapidly restored when nonirradiated hematogenic tissue was present in the organism, which is explained by migration of undamaged cellular elements and by the influence of humoral factors penetrating from intact tissue. (H.G.D.)

4856 REACTION OF THE AUTONOMIC NERVOUS SYSTEM TO SOME BIOGENIC AMINES AND TO NICOTINE. Nicolau, Elena; Muresan, V.; Voicu, V.; Doina, Anania. Rev. Sanit. Mil., 16: Special No., 487-90(1965). (In Rumanian).

Dogs were given 2 μg/kg of epinephrine or norepinephrine, 5 μg/kg of acetylcholine, or 5 to 10 μg/kg of nicotine before exposure to x-irradiation of 800 R. Results indicated that a nonspecific neurosympatholytic endogenous agent is present and circulating in radiation sickness. (JPRS)

4857 PARIETAL AND VISCERAL PLEURAL UNCONDITIONED REFLEXES TO CARDIOVASCULAR SYSTEM IN HEALTHY AND IRRADIATED ANIMALS. Bachurina, T. I. (Kirov Military Medical Academy, Leningrad). Radiobiologiya, 6: 232-6(1966). (In Russian).

The effects of unconditioned reflexes from the visceral and parietal pleura on the cardiovascular system were investigated before and after x-irradiation of cats under urethan narcosis. The visceral and parietal layers of the pleura represented a single powerful reflexogenic zone, from which reflex influences could be imposed upon the activity of the cardiovascular system. The depressor character of the reflex in the case of stimulation of the pleural receptors by acetylcholine was the result of vasomotor reactions, while the reflex changes in the cardiac activity were secondary and played a compensatory role. Changes observed in the unconditioned chemoreflexes from the pleura to the cardiovascular system after x irradiation of animals with medium doses were attributed to disturbance of the functional state of the receptors of the pleura and central nervous system. (H.G.D.)

4858 REFLEXES OF MECHANICAL RECEPTORS OF THE UPPER RESPIRATORY TRACTS DURING RADIATION SICKNESS. Felberbaum, R. A.; Yampolskii, L. N. (Scientific-Research Inst. of Ophthalmology, Otology, and Speech, Leningrad). Radiobiologiya, 6: 250-3(1966). (In Russian).

The reflex function of the upper respiratory tract was examined in cats exposed to 400 R of x rays and in nonirradiated controls. Stimulation of the mechanoreceptors of the trachea, sub- and supraligamental spaces of the larynx, and glottis 3 to 7 days postirradiation induced a substantial slowdown or inhibition of respiration and two-phase reactions of blood pressure (i.e., negligible depressor, alternating with substantial pressor). On the 16th to 17th days postirradiation, the reflexes on respiration and blood pressure from the mechanoreceptors of the trachea, larynx, and glottis were no longer detectable. (H.G.D.)

4859 TESTICULAR CHANGES IN ATOMIC BOMB SURVIVORS. Jordan, Scott W.; Hasegawa, Carl M.; Keehn, Robert J. (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). Arch. Pathol., 82: 542-54(Dec. 1966).

The testes of autopsied atomic bomb survivors were examined for evidence of radiation, and aging changes. Survivors less than 1400 meters from hypocenter at the time of the bomb explosion were compared with distally and nonexposed subjects using several histologic parameters. Chi-square tests showed statistically significant differences in the prevalence at death of tubular sclerosis and vascular hyalinization between the Hiroshima survivors less than 1400 meters from hypocenter and their controls. Very significant differences in seminiferous tubular sclerosis were found between the under 1400 meters survivors who received 300 rads or more whole-body radiation, the remainder of the under 1400 meters group, and the controls. Also, significant age dependent changes were found. A smaller proportion of under 1400 meters survivors 60 years of age or more at the time of the bomb had recorded signs or symptoms of radiation sickness than did their younger counterparts. (auth)

4860 ABSENCE OF MALIGNANT TRANSFORMATION AFTER WEEKLY IRRADIATION OF A MOUSE SPLEEN CELL CULTURE. Klein, J. C. (Radiobiological Inst. TNO, Rijswijk, Netherlands). J. Nat. Cancer Inst., 37: 655-61(Nov. 1966).

A nonmalignant mouse cell line was developed, which can be used for experiments on carcinogenesis. Special precautions were taken during the entire culture period to avoid the introduction of carcinogenic factors. Irradiation was tested in this in vitro system for its capacity to induce malignant transformations. The fact that exposure of the culture to weekly doses of 100, 200, or 300 rads of x radiation during a culture period of 1.5 years, up to total doses exceeding 10,000 rads, did not produce malignant changes suggested that the irradiation had no direct carcinogenic effect on cells in vitro. The absence of a carcinogenic effect of x rays in vitro cannot be attributed to a peculiarity of the cell line, since cells of this line did turn malignant in a parallel experiment after introduction of a known cytotoxic serum. (auth)

4861 GROSS SEQUELAE OF FETAL X-IRRADIATION OF THE MONKEY (MACACA MULATTA). I. EFFECT ON BODY AND ORGAN WEIGHTS AT 23 MONTHS. **Rugh, R.; Duhamel, L.; Skaredoff, L.; Somogyi, C. (Columbia Univ., New York). Atompraxis, 12: 468-73(Sept. 1966).**

Two fetally x-irradiated male monkeys were studied for 23 months, simultaneously with a male control, to determine the morphological and physiological effects. One experimental monkey received 200 R at 80 days and the other 300 R at 60 days gestation. All three were delivered normally, nursed by their mothers, and weaned at the proper time. The two x-irradiated monkeys showed consistent weight deficit when compared with the control, and organ weights at autopsy (at 23 months) showed the greatest deficit for the spleen, liver, lungs, and intestines. Skeletal deficiencies were shown by means radiographs and, as with the soft tissues, the monkey receiving the higher exposure at the earlier stage showed the greater permanent damage. The brains showed gross damage, particularly in the occipital and cerebellar regions. (auth)

4862 THE EFFECTS OF IRRADIATION ON LIVER FUNCTION BY ^{131}I-ROSE-BENGAL METHOD. Bando, Shoji (Tokushima Univ., Japan). Nippon Acta Radiol., 25: 101-14(May 1965). (In Japanese).

Iodine-131-Rose-Bengal was used in studies on liver functioning in rats given whole-body x irradiation and localized x radiation to the liver. The mean excretion time of the latter animals was prolonged after 200 R and returned to normal 6 hours after irradiation. At doses of 500 to 1000 R the excretion time was markedly prolonged and returned to normal after 24 hours. After whole-body radiation at 200 R the excretion time was shorter than that of the control. After doses of 500 to 1000 R the time was prolonged. The effects of radiation on liver functioning were direct during the early phases and indirect during the later phases. (H.L.W.)

4863 COMEDONE ERUPTIONS DURING RADIOTHERAPY. **Jucker, C.; Parabita, G. Ferrari (Univ., Pavia, Italy). Radiobiol. Radioterap. Fis. Med., 21: 253-9(July-Aug. 1966). (In Italian).**

Three cases of post-radiation comedones (blackheads) are reported. This is one of the less-known radiation effects; the reports are uncommon, partially because of clinical insignificance of the effect. (auth)

4864 MEASUREMENT OF CELLS AND NUCLEI OF HUMAN PIGMENTED SKIN TUMOURS AFTER IRRADIATION. **Ganina, K. P.; Naleskina, L. A. (Research Inst. of Experimental and Clinical Oncology, Kiev). Vop. Onkol., 12: No. 10, 40-4(1966). (In Russian).**

Regularities of the cellular and nuclear size changes were followed in the process of nevus malignization up to the development of malignant melanoma. It was found that the effect of x rays on various types of pigmented tumors differs depending on the degree of their malignancy. Regular increase of the cellular and nuclear sizes after x-irradiation of malignant elements of the nevus and malignant melanoma suggested additional diagnostic histological test that could be used even in the absence of the characteristic cytologic evidences. (auth)

4865 BIOLOGICAL ACTION OF ^{210}Po. Moskalev, Yu. I.; Petrovich, I. K.; Streltsova, V. N. Radiobiologiya, 6: 185-93 (1966). (In Russian).

Data are presented on the effects of ^{210}Po on the life span, composition of the peripheral blood, weight, and incidence of pathological and neoplastic processes in rats. Solutions of ^{210}Po chloride were administered intraperitoneally in amounts of 0.06, 0.12, 0.24, 0.48, 0.96, 2.0, 4.0, and 8.0 uCi/rat, which corresponded to 0.00035, 0.0007, 0.0014, 0.0028, 0.0056, 0.0117, 0.0236, and 0.047 uCi/g body wt. The LD_{50} values for 30, 60, 120, 240, 360, and 480 days were: 0.0272, 0.0240, 0.0169, 0.0087, 0.0060, and 0.0019 uCi/g body wt. Females were more radiosensitive than males to early effects from acute and subacute doses. The shape of the dose-effect curve for erythrocytes, neutrophils, and lymphocytes depended upon the time of observation. Latent effects included cirrhosis of the liver, nephrosclerosis, dyshormonal disorders, and neoplasms of the kidneys, large intestine, testes, prostate gland, subcutaneous tissues, pituitary, thyroid, mammary glands, and uterus. (H.G.D.)

4866 ON AN OBSERVATION OF OSTEONECROSIS AND MALIGNANT TUMOR AFTER GYNECOLOGICAL X IRRADIATION. **Brezina, K. (Kaiser-Franz-Josef-Spitals, Vienna). Krebarzt, 20: 265-8(1965). (In German).**

Because of an inoperable uterine carcinoma a 67-yr-old patient was treated intravaginally with 2400 mg-hr of Ra and intrauterinally with 5920 mg-hr of Ra. In addition, the patient was irradiated over a period of 6 months with 3 x-ray series. One amounted to 4500 R and the other two series each totaled 5000 R surface dose. The irradiation consisted of 2 lower abdominal fields and 2 dorsal fields, each 10 × 15 cm. At 2 months after the irradiation treatment the patient suffered a medial fracture of the head of the right femur. This was repaired by nailing, but required second nail a yr later. This caused destruction of the necrotic head of the femur. The nail was removed and a plastic prosthesis substituted. Then 12 yr after the irradiations the patient developed a calcified tumor in the left hip joint that completely surrounded the upper femur and extended toward the central portion of the pelvis and the pubic bone. The tumor was identified as an osteochondrofibrosarcoma. It was estimated that, because of the comparatively high irradiation absorption of bone, the femur head might have absorbed between 10,000 and 18,000 R. This is far above the critical dose that has been estimated to produce osteoradionecrosis. (BBB)

4867 ON THE EXPERIMENTAL PRODUCTION OF TUMORS OF THE THYROID GLAND WITH RADIATION. **Eichler, O.; Hoebel, M. (Univ., Heidelberg). Arch. Klin. Chir., 31: 209-20(Aug. 30, 1965). (In German).**

Malignant tumors of the thyroid gland were induced in rats of the Lister and Long-Evans strains by administration of 30- to 40-μC doses of ^{131}I to the young animals. A comparable effect in thyroid carcinogenesis could be produced by x irradiation of the neck region with doses of 1000 R. This x-ray dose was previously estimated to be equivalent to 30 μC in the rat thyroid gland which irradiate this organ with ca 10,000 rad. This apparently increased sensitivity to x radiation as compared to ^{131}I cannot be explained until it is determined whether the β or γ emission of ^{131}I is mainly responsible for the carcinogenic effect. It is pointed out that as a result of the small size of the rat thyroid gland and the, therefore, unfavorable geometry, a significant portion of the ^{131}I radiation acts on the stromal tissue rather than the parenchymal (follicular) cells. The tumors induced occurred mostly in the second third of the animals' natural lifespan. The significance of these results to the use of ^{131}I in treating benign thyroid diseases is discussed. (BBB)

4868 CORNEAL AND CONJUNCTIVAL COMPLICATIONS FOLLOWING RADIOTHERAPY. **Bedford, M. A. (Moorfields Eye Hospital, London). Proc. Roy. Soc. Med., 59: 529-30(June 1966).**

Complications arising from irradiation of the cornea and conjunctiva are discussed. Lid necrosis occurs only rarely today, as the dose of radiation is more strictly controlled, but the lid receives a tumor-lethal dose throughout its thickness. Thus, the conjunctiva on the back of the lid may show permanent changes. Telangiectasia of the conjunctival vessels occurs and is of no significance when localized. However, local loss of glandular tissue and metaplasia of conjunctiva may appear as a well-defined, heaped-up, crumbling white lesion. When generalized, telangiectasia may be associated with secondary open angle glaucoma and may be seen after conventional x rays, cobalt beam therapy, and even after large doses of β radiation. Some cases may require surgery. The other two basic changes which may be seen involving the bulbar conjunctiva are so-called dry eye and corneal ulcerations. The relatively minor syndrome of dry eye can be immensely aggravated when the whole of the orbit is being irradiated for a tumor of the paranasal sinuses. Corneal ulcers are characteristically indolent, involving the greater thickness of the cornea; they may be central or marginal. Another corneal condition is an apparently rare type of dystrophic change occurring after β irradiation; it is characterized by epithelial and stromal edema with a marked loss of corneal sensation. These corneal changes occur in the absence of increased pressure and are presumably due to a loss of integrity of Descemet's membrane. (TCO)

4869 CHROMOSOME DAMAGE AFTER ^{131}I THERAPY. **New Eng. J. Med., 275: 786-7(Oct. 1966).**

Some hazards of ^{131}I therapy of hyperthyroidism are discussed: hypothyroidism, induction of tumors and nodules, and especially chromosome aberrations. The abnormalities observed in leukocyte chromosomes after administration of radioiodide previously were thought to be transient and associated only with high doses of radiation. However, persistent chromosomal abnormalities have now been reported to occur after standard amounts of radioiodide used for the therapy of hyperthyroidism, a 5-mC dose producing about 5-rad exposure to the body. An increase in chromatid abnormalities has been found and, more importantly, chromosomal abnormalities typified by the occurrence of acentric chromosome fragments. No decrease in the incidence of acentric fragments has occurred during 1 yr of observation. Presumably, the leukocytes under culture have a finite lifespan, and at the end of the year it is likely that the cultured cells would be one or more generations removed from the originally exposed cell. Whether such fragments can replicate adequately without a centromere is not known. (BBB)

4870 EARLY ADYNAMIA IN THE RADIATION SICKNESS. Belokonski, I.; Rusev, G.; Kraev, D.; Seicov, N.; Popov, P. Rev. Sanit. Mil., 16: Special No., 427-37(1965). (In Rumanian).

Radioinduced muscular weakness was studied in mice, rats, and dogs exposed to 450, 900, 1800, or 5000 R. Conditioned reflex response and other central nervous system functions; spontaneous motor activity; muscular response to electrical stimulation; metabolism of K, Na, and Ca in the muscles; and actinomycin contractility were noted. (TSS)

4871 EVOLUTION OF RENAL LESIONS IN RADIATION SICKNESS. Augustin, Al.; Grigorescu, C.; Strimbeanu, I.; Giurgiu, T.; Ionescu, P.; Marinescu, I.; Roman, I. Rev. Sanit. Mil., 16: Special No., 453-8(1965). (In Rumanian).

Irradiation with 440 R x rays in rabbits, followed by unilateral nephrectomy at 6 or 24 hours thereafter, and careful histopathological study of the remaining kidney 23 of 35 days after the first operation, revealed that radiation disease brings about specific processes in kidney and delays healing and cicatrization. (JPRS)

4872 EXPERIMENTAL STUDY ON PLEUROPULMONARY WOUNDS IN IRRADIATED ANIMALS. Niculescu, Gh.; Strimbeanu, I.; Giurgiu, T.; Safta, T.; Danciuloiu, Al. Rev. Sanit. Mil., 16: Special No., 464-6(1965). (In Rumanian).

Dogs were exposed to 400 R 6, 12, or 24 hrs prior to lobotomy, lobectomy, or pneumonectomy. Development of pulmonary lesions was less rapid and lesions were less severe in irradiated animals than in nonirradiated controls. (TSS)

4873 EXPERIMENTAL STUDY OF THE PROCESS OF WOUND HEALING OF VESICAL LESIONS IN IRRADIATED ANIMALS. Augustin, Al.; Grigorescu, C.; Giurgiu, T.; Singer, D.; Barbilian, Gh.; Marinescu, I.; Safta, T. Rev. Sanit. Mil., 16: Special No., 459-60(1965). (In Rumanian).

Cystotomy in rabbits irradiated 6 or 12 hours before surgery revealed that wounds were much slower and less apt to heal properly than in nonirradiated controls. (JPRS)

4874 EXPERIMENTAL STUDY ON HUMORAL AND FUNCTIONAL CHANGES IN THE SYNDROME CAUSED FROM COMBINED ACTION OF BURNS AND WHOLE BODY IRRADIATION. Giurgiu, T.; Ionescu, P.; Safta, T.; Macarie, O.; Niculescu, Aurelia. Rev. Sanit. Mil., 16: Special No., 466-73(1965). (In Rumanian).

Second and third-degree burns were applied to dogs 1,2, or 24 hrs or 5 days after x-irradiation (500R). Mortality was 55% in unirradiated, burned controls; 100% in animals burned and irradiated; and 100% in irradiated controls. The latter group survived 1 to 7 days longer than the group administered both stresses. Hematologic data are discussed in detail. (TSAT)

4875 PROTECTIVE AND REGENERATIVE REACTIONS OF THE ORGANISM AT VARIOUS DOSES. Dzhaparidze, T. N. (Inst. of Experimental and Clinical Surgery and Hematology, Academy of Medical Sciences, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 43: 221-5(July 1966). (In Russian).

Artificial hypothermia is one of the chief methods to reduce the reactivity of the organism, as it depresses the metabolic processes. The problem was studied by exposing 50 dogs to lethal and sublethal x radiations, including single exposures of 400 to 600 R and repeated doses of 20 to 50 R up to a total dose of 400 R. The effects were observed clinically by hemorrhaging, changes in weight and temperature, and by studying the peripheral blood composition, the phagocytic activity of leukocytes and the overall activity of the blood coagulating system. The results indicated that the protective action of the organism is enhanced if repeated small doses are allowed to act on it, instead of a single large dose. While lethal doses caused deep, degenerative necrobiotic changes, cooling the animals to 22 to 23°C resulted in only relatively mild radiation sickness and a favorable clinical picture. (TTT)

4876 EFFECT OF WHOLE-BODY X-IRRADIATION ON THE ERYTHROPOIETIC ACTIVITY OF THE BLOOD OF ANEMIZED ANIMALS. Arutyunyan, R. A. (Inst. of Physiology, Academy of Sciences, USSR. Dept. of Radiology, Erevan). Izv. Akad. Nauk Arm. SSR. Ser. Fiz. Mat. Nauk, 18: No. 4, 22-8(1965). (In Russian).

Healthy mature chinchilla rabbits were exposed to 600 R of x rays and desanguinated 24 hours later. Erythropoietic activity was then investigated in vivo and in vitro. Irradiation of the anemized animals had no pronounced effect on erythropoiesis. The reticulocyte content of the peripheral blood showed a slight tendency to increase, but this change was statistically insignificant. In vitro experiments gave similar results. Addition of a protein-free extract of plasma or whole plasma to a bone-marrow culture failed to stimulate growth of elements on the erythroblast series. Thus, exposure of desanguinated animals to 600 R of x rays prevents intensification of erythropoietic activity. Two possible explanations of the phenomenon are offered: by acting on various organs and tissues, x-irradiation simultaneously affects the processes responsible for increased elaboration of erythropoietins in response to acute bleeding; and radiation lesions of tissues and organs cause functional disorders that result in the formation of active substances with toxic and hemolytic properties. (auth)

4877 EFFECT OF X-RAYS ON THE SUBSEQUENT DEVELOPMENT OF EMBRYONIC GONADS IN THE MALE GOLDEN HAMSTER. **Zdobylak-Horecka, Halina (Radiological Clinic, Krakow). Folia Biol., 14: 243-60(1966).**

Female golden hamsters were irradiated with 30, 50, and 70 R of x rays 10 days post coitum. After doses of 50 and 70 R the sex ratio of the progeny of irradiated mothers showed a shift in favor of females. The testes of males born of mothers irradiated with 30 R were not inhibited in development or altered histologically. Changes in the testes were observed when the pregnant mothers were irradiated with 50 or 70 R, though they were manifested later. Seven days post partum (p.p.) the testes of these animals did not differ from the controls but 30 and 60 days p.p. developmental disorders of the testes were distinct. Individual radiosensitivity varied greatly. Males from the same litter exhibited either completely normal or completely degenerated testes. (auth)

4878 PHASIC CHANGES OF THERMOREGULATION IN RABBITS DURING TOTAL X-IRRADIATION (THERMOGRAPHIC OBSERVATION). Kadykov, B. I.; Lyutinskii, S. I.; Balanin, V. I. (Inst. of Veterinary, Leningrad). Radiobiologiya, 6: 315-18(1966). (In Russian).

Whole-body x-irradiation of rabbits induced disturbances in thermoregulation and heat production, which occur in three phases: a phase of hypothermia with reduced heat production in the liver, striated muscles, a drop in the rectal and skin temperatures; a phase of relative hyperthermia, characterized by a relative increase in the heat production in the liver, striated muscles, and an increase in the rectal and skin temperatures; and a phase of hypothermia, with a drop in the heat production in the liver, striated muscles, and a decrease in the rectal and skin temperatures. Cessation of irradiation at the beginning of the second (hyperthermic) phase did not prevent its development, but, led to an even more intensive and prolonged increase in the temperature than in the case of a continuous radiation insult. Cessation of irradiation at the very beginning of the third (hypothermic) phase also failed to inhibit development. Feverish rabbits were more radiosensitive than those with normal body temperatures. (H.G.D.)

4879 INFLUENCE OF SOME PEROXIDES AND IONIZING RADIATION ON MICE. Popov, A. S. Radiobiologiya, 6: 206-9 (1966). (In Russian).

The effects of γ radiation and hydrogen, urea, and succinic acid peroxides on mice were studied. It was found that the lethal doses of succinic acid peroxide are 100 times lower than the dose of hydrogen and urea peroxides. It was shown that there is no similarity in the effects of radiation and peroxides on the lifetime and change in weight of the animals. It was established that the comparative toxicities of certain organic peroxides for mammals and protists are quite different. Succinic acid peroxide is most toxic for mice and least for Paramecia. (H.G.D.)

4880 QUANTITATIVE AND QUALITATIVE EVALUATION OF SKIN ERYTHEMA. III. EFFECT OF VARIATION IN TEMPERATURE. Charyulu, K. K. N.; Tyree, E. B.; Glicksman, A. S.; Nickson, J. J. (Sloan-Kettering Inst. for Cancer Research, New York). Radiology, 87: 917-21(Nov. 1966).

The alteration of the radiosensitivity of human skin, as a result of modifying skin temperature, was investigated. Irradiation of the skin at temperatures of 39 or 44°C produced a reaction sooner and more intense than that resulting from irradiation of the skin at ambient temperature. Decrease in skin temperature to as low as 8°C did not modify the effects of radiation, but delayed the appearance of maximal reaction. (auth)

4881 PECULIARITIES OF RADIATION SYNDROME DEPENDING ON THE PLACES OF DISTRIBUTION OF ABSORBED ENERGY. Savchenko, N. Ya. Radiobiologiya, 6: 330-1(1966). (In Russian).

The effects of the distribution of absorbed dose on the development of radiation sickness was studied in dogs exposed to 80- and

180-kV x rays. A comparison of the biological effectiveness of radiations with various models of dose distribution revealed substantial differences both in the death rate and in the peculiarities of the clinical manifestation of radiation injury. In the case of uniform distribution of absorbed dose, the dogs developed the classical picture of radiation sickness, with death of all animals between 12 and 18 days postirradiation. When the absorbed dose was reduced, all dogs survived. (H.G.D.)

Radiation Effects on Plants

Refer also to abstract 4789.

4882 INFLUENCE OF SEED CULTIVATION CONDITIONS ON DISPLAY OF RADIOBIOLOGICAL EFFECTS DURING SUBSEQUENT IRRADIATION OF THE SEEDS WITH FAST NEUTRONS. Ponomarev, G. V. (Scientific-Research Inst. of Agricultural Physics, Leningrad). Radiobiologiya, 6: 294-7(1966). (In Russian).

Data supporting the dependence of neutron damage on the physiological state of the organism at the time of exposure were collected in wheat from seeds grown in highly fertile soil or depleted media. The appreciably greater neutron sensitivity of seeds from a background of low soil fertility was manifested in lower germination and higher death rate of mature plants. Under conditions of insufficient nutrition, injuries to respiratory enzymes and storage compounds with high-energy bonds occurred more frequently due to the greater radiosensitivity of the plants. (H.G.D.)

4883 DEPRESSANT EFFECT OF SMALL DOSES OF IONIZING RADIATION ON GROWING PLANTS. Vavilov, P. P.; Verkhovskaya, I. N.; Popova, O. N.; Kodaneva, R. P. (Komi Branch, Academy of Sciences, Syktyvkar, USSR. Inst. of Biochemistry, Moscow). Radiobiologiya, 6: 278-83(1966). (In Russian).

In view of previous findings that the growth of Vicia faba is significantly delayed in areas with large deposits of uranium or radium, similar experiments were carried out over a 2-year period with spring wheat and spring barley grown in experimental plots under the influence of gamma radiation from U and Ra ore (radiation dose of 0.005 to 0.1 R/day). The height, internodes, dry weight, number of heads, and number of grains per head were measured in both experimental and control plots. Although radiation had no significant effect on germination rate of either wheat or barley, it produced a marked delay in heading and tillering and thus significantly decreased the biological productivity of the crops. (ATD)

4884 INFLUENCE OF γ IRRADIATION OF RYE SEEDS ON THE DYNAMICS OF THE ACCUMULATION OF CHLOROPHYLL AND CAROTENE. Bogdashevskaya, O. V.; Runova, Yu. N. (Orekhovo-Zuevskii Pedagogical Inst., USSR). Radiobiologiya, 6: 288-91(1966).

The effects of γ-irradiation of dry seeds of spring rye on the dynamics of chlorophyll and carotene accumulation in the mature plant were examined. Carotene accumulation was accelerated in all phases of plant development by a dose of 500 R and in early phases of development by a dose of 1 kR, but was reduced in all phases by 5 kR. Gamma-irradiation of seeds in small doses stimulated the formation and accumulation of chloroplast pigments to one degree or another, a phenomenon observable only in later stages of development. (H.G.D.)

4885 EFFECTS OF ULTRAVIOLET RADIATION ON THE PHOTOSYNTHESIS IN HELIOPHILOUS AND SHADE-TOLERANT PLANTS. Kacharava, N. F. (Inst. of Botany, Academy of Sciences, Georgian SSR). Soobshch. Akad. Nauk Gruz, SSR, 43: 723-7(Sept. 1966). (In Georgian).

Studies of ultraviolet effects on plants growing at high elevations (1700 m) in Bakuriani and at 450 m elevations in Tbilissi showed that the ultraviolet intensity was 2 to 2.5 times as strong as at lower elevations. Thus, the higher rate of photosynthesis in plants growing in Bakuriani was induced by ultraviolet radiation as well as by higher temperature. An additional ultraviolet source produced by a quartz tube stimulated photosynthesis in plants growing in Bakuriani and in Tbilissi. The effects of ultraviolet rays were more pronounced in the shade-tolerant plants than in heliophilous plants. (R.V.J.)

4886 BIOSYNTHESIS OF ACID INDOLAUXINS IN YOUNG BARLEY PLANTS LABELED WITH ^{14}C. EFFECTS OF IRRADIATION ON SEEDS. Picciurro, G.; Cervigni, T. (CNEN, Rome). Giorn. Bot. Ital., 71: 420-2(1964). (In Italian). (RT/BIO-(65)23).

Young plants were divided into several groups and kept under similar growth conditions. An apparatus was designed to study radiation effects on synthesis of acid indole derivatives in barley seeds. Solutions of acid indolauxins (IAA) were irradiated and little radiosensitivity was demonstrated. This indicates that the decrease of IAA in irradiated plants is due to a decrease in biosynthesis rather than to direct action of radiation on the molecule. The purpose of this investigation was to study changes in acid indolauxin metabolism. Young barley plants from irradiated and control seeds were placed in an atmosphere of carbon-14-labeled carbon dioxide on the seventh day after sowing and left for 42 hours. There was no decrease in synthesis of acid indolauxin in plants from irradiated seeds; there was actually an increase of synthesis in the leaves. Decreased growth in irradiated plants is not due to decreased synthesis of auxins, but to alteration of other regulator systems. It is possible that decreased growth may be attributed to decreased sensitivity of tissues to auxins. (H.L.W.)

4887 REGENERATION OF LIVE ORGANISMS FOLLOWING THE ACTION OF IONIZING RADIATION. IV. ACTION OF SOME BIOCATALYSTS ON SOYBEANS UNIRRADIATED AND IRRADIATED WITH X-RAYS. Cerkovnikov, E.; Steiner, Aleksa; Kirigin, M. (Univ., Zagreb). Acta Pharm. Jugoslav., 15: 127-37(1965).

The radioprotective effect of the plant hormones, 2,4-dichlorophenoxyacetic acid and phenylmercaptoacetic acid, was studied using x irradiated soybean seeds. Results of in vitro experiments were similar to those carried out in the field. Partial protection against the inhibitory effects of radiation could be demonstrated. (H.L.W.)

Radiation Effects on Microorganisms

4888 THE INTERFERENCE ACTIVITY OF UV-IRRADIATED NEWCASTLE DISEASE VIRUS (ND_{uv}). Russeff, Christo; Mateva, Vera; Wassilewa, Lilia (Veterinary Inst. for Infectious and Parasitic Diseases, Sofia). Zentralbl. Bakteriol. Parasitenk., Abt. I. Orig., 198: 391-404(1965). (In German).

The phenomenon of virus interference was studied in vitro with a virus strain nonpathogenic for tissue cultures of calf kidney. The Newcastle disease virus strain was inactivated by uv irradiation. It was established that this interference activity is due to interferon and not to elementary virus particles. On the other hand, a cytopathogenic NDV strain with high infectious titer, after uv irradiation, showed interfering activity which originated from the elementary virus particles themselves. The interfering activity of the supernatant of tissue cultures inoculated with the first strain was resistant to prolonged uv irradiation, to acid (pH 2) dialysis, to neutralization by anti-NDV serum, and to ultracentrifugation at 105,000 g. However, this activity is sensitive to trypsin and is tissue specific. The interfering activity of NDV with high infectious titer obtained from chicken embryos after uv irradiation is resistant to trypsin and is lost after neutralization with anti-NDV serum. This is due to the elementary virus particles themselves. The time of appearance, duration, and degree of the interference caused by NDV_{uv} in tissue cultures were determined. (BBB)

4889 THE INFLUENCE OF X-RAYS ON THE FLAVINOGENESIS OF CANDIDA MELIBIOSI YEASTS AS A FUNCTION OF THE PHYSIOLOGICAL STATE OF THE CELLS AND THE CONDITIONS OF THEIR INCUBATION. Skvarko, K. A. (Franko State Univ., Lvov). Mikrobiol. Zh., Akad. Nauk Ukr. RSR, 27: 48-53(1965). (In Ukrainian).

Radioinduced changes in flavinogenesis in Candida melibiosi depended upon age of culture. In irradiated cells taken from the lag phase of growth, stimulation of riboflavin biosynthesis was observed, but such stimulation failed to appear in x-irradiated stationary cells. Intense aeration of young cultures was required for the stimulation of flavinogenesis. Enhancement of flavinogenesis in young C. melibiosi cells did not depend on the initial intensity of riboflavin biosynthesis, which was conditioned by Fe content in the cells. (H.G.D.)

4890 IRRADIATION INFLUENCE ON BIOLOGICAL PROPERTIES OF THE STIMULUS OF BACTERIAL CANCER ON TEA BUSHES. Tsilosani, G. A. (Inst. of Plant Protection, Tbilici, USSR). Radiobiologiya, 6: 323-5(1966). (In Russian).

Growth of Xanthomonas gorlencovianum on nutrient medium with high ^{35}S specific activity is retarded in comparison with the control or with growth on a medium with low specific activity. The maximum amount of the isotope is contained by five-day cultures. A medium on which five-day radioactive cultures were grown lost its ability to fluoresce. The radioactive cultures weakly decompose starch, but do not liquefy gelatin. Bacteria grown on nutrient medium with high specific activity exhibit weakened virulence. The incubation period on the tea leaf was longer for organisms grown on radioactive media than in controls. (H.G.D.)

Radiosterilization and Radiopreservation

Refer also to abstract 5595.

4891 (UCD-34P80-4) RADIATION TECHNOLOGY IN CONJUNCTION WITH POSTHARVEST PROCEDURES AS A MEANS OF EXTENDING THE SHELF LIFE OF FRUITS AND VEGETABLES. Annual Report, February 1, 1965–January 30, 1966. Maxie, E. C.; Sommer, N. F.; Brown, D. S. (California Univ., Davis. Dept. of Pomology). Oct. 1966. Contract AT(11-1)-34. 135p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Bananas showed marked inhibition of ripening when subjected to doses of 25 to 50 krad of gamma radiation. Doses as low as 15 krad were effective. Irradiated fruit could be held for 8 to 26 days in the green state. When subjected to standard ethylene (C_2H_4) gas treatments (1,000 ppm for 18 to 24 hr), the irradiated bananas ripened to excellent quality as determined by taste-panel evaluation. There was secondary inhibition in onset of senescence of the irradiated fruit, with the treated lots remaining at color-stage 6 for 1 to 2 days. If bananas had begun to ripen, irradiation was ineffective in retarding ripening. Doses of 25, 35, and 50 krad gave increased amounts of ascorbic acid, niacin, and thiamine in Gros Michel bananas. This was interpreted to mean greater extractability, rather than a net synthesis, of the vitamins in the irradiated bananas. Valery bananas did not respond as favorably to irradiation as did the Gros Michel. The Valery bananas had been shipped by air from Honduras and suffered a much greater incidence of mechanical injury than the Gros Michel fruit, which were shipped via banana ship. Mechanical injury was shown to stimulate ripening in bananas. Gamma irradiation could partially offset the ripening stimulus of mechanical injury. Gamma irradiation to 200 krad markedly increased the susceptibility of peaches and nectarines to simulated transit injury. The "tight-fill" method of packing reduced the severity of transit injury to irradiated nectarines. Analyses for anthocyanin in irradiated Suncrest No. 72 and Elberta peaches showed a net increase in the red pigment. Post-irradiation storage of oranges at temperatures of 29, 32, 36, 41, 59, 68, and 77°F gave rind pitting to some degree within 5 weeks at every temperature. Fruits held at 59°F showed the most severe injury. Waxing reduced the pitting, indicating that water loss may be involved. The shelf life of tomatoes harvested at the pink to table-ripe stages of ripeness was extended by 4 to 12 days at 250 and 300 krad. Heat and gamma irradiation in combination show a marked synergistic effect on the inactivation of several fruit-rot fungi. (auth)

4892 (UH-235P5-2) DOSIMETRY, TOLERANCE, AND SHELF LIFE EXTENSION RELATED TO DISINFESTATION OF FRUITS AND VEGETABLES BY GAMMA IRRADIATION. Period Covered: June 1, 1965–May 31, 1966. Akamine, E. K.; Brewbaker, J. L.; Buddenhagen, I.; Hilker, D.; Kinch, D.; Moy, J.; Ross, E.; Spielmann, H.; Upadhya, M.; Young, R. (Hawaii Univ., Honolulu. Coll. of Tropical Agriculture). Sept. 1966. Contract AT(04-3)-235. 106p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Food irradiation studies using the Hawaii Research Irradiator are reported. Three commodities have been studied in great detail: the papaya, mango, and pineapple. Evidence obtained for each fruit attests to the biological feasibility of gamma irradiation for insect disinfestation. Associated studies suggest possible applications of gamma irradiation in commodity treatments of ginger, sweet potatoes, and even of Hawaiian fishcake, while its successful application for disinfestation of tangerines and avocadoes appears unlikely. Dosimetry studies were extended to include dose-response patterns when the central chamber was filled with water or papaya juice. (F.S.)

4893 USE OF RADIONUCLIDES AND THEIR RADIATION IN THE PLANT PEST CONTROL. Haisch, A.; Suess, A. (Bayerische Landesanstalt fuer Bodenkultur, Munich). Kerntechnik, 8: 514-17(Nov. 1966). (In German).

The use of labeling techniques to determine the relation between plant, plant pest, and environment to ensure a more effective use of pesticides is discussed. The use of ionizing radiation for killing and sterilizing plant pests is also discussed. Pest sterilization is considered in some detail with the discussion of the modification of the sterilization by endo and exogenic factors, and a review of the results obtained in sterilization studies is given. (J.S.R.)

4894 STERILIZATION AND PASTEURIZATION BY HIGH-ENERGY RADIATION. Diehl, J. F. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Kerntechnik, 8: 506-10(Nov. 1966). (In German).

The development of sterilization and pasteurization by high energy radiation is reviewed. Possible areas of application and the radiation doses required are discussed and tabulated. The safety of irradiated food is emphasized. The legal situation with respect to the sale of irradiated food is briefly discussed. (J.S.R.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

4895 (EUR-3121.d,f,e) PROCEEDINGS OF THE COLLOQUIUM ON BRITTLE FRACTURE AND SAFETY PROBLEMS IN NUCLEAR PRESSURE VESSELS, BRUSSELS, JANUARY 11-13, 1966. Sebille, J. (ed.) (European Atomic Energy Community). Sept. 1966. 791p. (In Dutch, French, and English). (CONF-660117). Dep. mn.

4896 (NASA-SP-7020(01)) LUBRICATION, CORROSION, AND WEAR. A Continuing Bibliography with Indexes. (National Aeronautics and Space Administration, Washington, D. C.). Oct. 1966. 304p. CFSTI $3.00 cy, $0.65 mn.

A selection is presented of annotated references to unclassified reports and journal articles that were announced in Scientific and Technical Aerospace Reports or in International Aerospace Abstracts. Each entry in the bibliography consists of a citation and an abstract. (J.R.D.)

4897 (JPRS-37911) ELECTROVACUUM MATERIALS: ASSORTMENT AND USE. Lebedinskii, M. A. Translated from pp 88-90; 103-6; 117-21; 132-4; 137-41; 160-1; 168-9; 177-8; 182-193; 197; 202-3; 207; 210-11; 215-20; 229 of Elektrovakuumnye Materialy, Metally i Splavy, Energiya, Moscow-Leningrad, 1966. 38p. (TT-66-34339). CFSTI $2.00 cy, $0.50 mn.

Shapes and uses in vacuum electronic equipment are discussed for the following metals and alloys: W, Mo, Ta, Nb, Ti, Zr, Re, W-Mo, Mo-Re, W-Re, Ta-Nb, W-Nb, Ni, Fe, Cu, Al, Fe-Ni, Fe-Ni-Cr, Kovar, Fe-Cr, Ni-Cr, Cu alloys, refractory alloys, alkaline metal alloys, alkaline earth metal alloys, Mg alloys, Hg alloys, noble metals, and brazes. (D.L.C.)

Corrosion and Erosion

Refer also to abstract 4480.

4898 (BNL-10723) THE BEHAVIOR OF REFRACTORY METALS AND ALLOYS IN BOILING SODIUM AND OTHER ALKALI METALS. Romano, A.; Fleitman, A.; Klamut, C. (Brookhaven National Lab., Upton, N. Y.). [1966]. Contract AT-30-2-GEN-16. 19p. (CONF-661110-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

A study was undertaken to determine whether Na and Cs (boiling and liquid) can be contained in refractory metal alloys. Other alkali metals were also tested in these alloys to compare their corrosiveness with that of Na and Cs. Of all the refractory metal alloys tested, alloy FS-85 (Nb-27Ta-10W-1Zr) was the most susceptible to corrosion by Na; intergranular penetration as deep as 0.05 mm was detected in one test. Several other alloys exhibited very slight transgranular corrosion by Na, but most of the alloys were not attacked. None of the alloys seem to be susceptible to stress-induced corrosion. The compatibility of two alloys (Nb-1Zr and Nb-10W-1Zr) with Li, Na, K, Rb, and Cs was also evaluated. In general, very slight corrosion was detected in these tests; although K seemed to be the least aggressive of the alkali metals in Nb-1Zr, there was no corrosion of Nb-10W-1Zr detected. Of all the alkali metals, Cs offers the most attractive thermodynamic properties relative to optimum turbine design. The alloys TZM and TZC were tested under conditions of high velocity vapor impingement (245 m/sec) at 840°C for 1096 hr in a forced circulation loop fabricated completely of refractory metals. Results of this test showed no corrosion or erosion of either of the test materials but a 0.025 mm-thick deposit of Nb was found on each blade. (auth)

4899 (CEND-3256-264) CORRELATIONS BETWEEN SENSITIZATION AND STRESS CORROSION CRACKING OF 300 SERIES STAINLESS STEELS. Final Summary Report. Koziol, J. J.; Christopher, S. S. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Sept. 1966. Contract AT(30-1)-3256. 82p. (EURAEC-1568). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

The effects of preoxidation and variations in surface conditions on the susceptibility to transgranular cracking of Types 304 and 347 stainless steel were studied. Tubing with annealed, drawn, swaged, and diffused Ni surfaces was exposed to an aqueous environment to evaluate the differences in behavior of nonstabilized and stabilized types (304 and 347) of stainless steels under identical test conditions. Tubes with swaged surfaces (15% R. A.) and surfaces containing diffused Ni layers showed improved resistance to transgranular cracking when compared with the other samples evaluated in this program. A trend toward increased susceptibility to transgranular cracking, which was observed for preoxidized and sensitized Type 304 stainless steel confirmed the possibility of interaction between grain boundary oxidation and transgranular cracking. (auth)

4900 (N-66-29401) SALT STRESS CORROSION OF Ti-8Al-1Mo-1V ALLOY SHEET AT ELEVATED TEMPERATURES. Heimerl, G. J.; Braski, D. N.; Royster, D. M.; Dexter, H. B. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). [1965]. 28p. CFSTI $3.00 cy, $0.65 mn.

In the investigation of the salt stress corrosion of Ti-8Al-1Mo-1V alloy sheet, many small self-stressed and residual stress specimens were salt coated, exposed up to 6400 hours at 400 to 600°F, and tested at room temperature to determine the extent of the stress corrosion cracking. Coatings of NaCl were more corrosive than $CaCl_2$, $MgCl_2$, or sea salt, and thin coatings were more damaging than thick. Environmental tests showed that a decrease in O_2 and air pressure reduced stress corrosion, but that the role of moisture and air velocity still remained in doubt. Stress corrosion cracks were intergranular, and a correlation was obtained between the results of the room-temperature corrosion tests and the crack penetration. $TiCl_2$ appeared to be one of the corrosion products. Surface treatments such as shot peening, Ni plating, vibratory cleaning, and polyimide coatings proved effective in preventing corrosion for exposures up to 2000 hours at 600°F. (auth)

4901 (ORNL-4028) MASS-TRANSFER EFFECTS IN SOME REFRACTORY-METAL-ALKALI-METAL-STAINLESS STEEL SYSTEMS. DiStefano, J. R. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Dissimilar-metal interactions between Nb or Nb-1% Zr and type 316 or 318 stainless steel in Na or NaK were investigated in static capsules at 816 to 982°C. The principal interaction was the transfer of C and N_2 from the stainless steel to the Nb or Nb alloy. Complex carbide-nitride layers formed on the surface of the Nb and N_2 but not C diffused appreciably into the Nb. The subsurface N_2 pickup greatly increased tensile strength and decreased ductility. The amount of C and N_2 transfer depended on temperature, exposure time, and ratio of surface areas of the dissimilar metals. The transfer was independent of stress and occurred to the same extent with types 316 and 318 stainless steels. (auth)

4902 (ORNL-4034) MATERIALS COMPATIBILITY AND CORROSION STUDIES FOR THE ARGONNE ADVANCED RESEARCH REACTOR. Griess, J. C.; English, J. L. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A material compatibility and corrosion investigation was conducted to determine the extent of corrosion to be expected in certain parts of the Argonne Advanced Research Reactor (AARR). The areas of concern were the Be reflector, the Al beam tubes and the stainless steel fuel element cladding, all of which are exposed to the primary coolant. All experiments were conducted in deionized water with a specific resistivity of 1 million ohm-cm or greater. The Be was free of localized attack, and neither crevices nor contact with stainless steel or Al produced adverse effects. The ratio of Be surface area to volume of water in the AARR is 2.3 cm^2/liter and the Be reflector would be expected to corrode at a rate between 1.1 and 2.8 mils/yr, either of which would be acceptable. The corrosion of 6061-T6 Al, the material from which the beam tubes will be made, results in the formation of an insulating layer of corrosion products. Test results indicate that if the surface temperature of the beam tubes in the AARR can be maintained at 200°F or less, the rate of corrosion, and consequently the rate of corrosion-product buildup on the surfaces, will be low enough to prevent excessive temperatures in the beam tube walls. Tests showed that in type 304 stainless steel after a 1000-hr exposure at a heat flux of 4.0×10^6 Btu/hr-ft^2, numerous shallow (~0.2 mil deep) cracks were present on the cooled surface. In a comparable test in which the heat flux was 2.1×10^6 Btu/hr-ft^2 (hot-spot heat flux for 100 Mw operation of AARR) and the exposure time was 2000 hr, no cracks were found. In view of the failures experienced in stainless steel fuel-element cladding in both pressurized and boiling water reactors, it is recommended that further investigation into this type of cracking be carried out. (J.R.D.)

4903 (ORNL-P-2704) CORROSION OF IRON- AND NICKEL-BASE ALLOYS IN HIGH-TEMPERATURE SODIUM AND NaK. DeVan, J. H. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 25p. (CONF-661110-4; SM-85/32). DTIE.

From IAEA Symposium on Alkali Metal Coolants, Corrosion Studies, and System Operating Experience, Vienna, Austria.

Operation of forced-convection corrosion loops of high-temperature alloys with Na and NaK at hot-leg temperatures from 1000 to 1650°F are described. The loops were electromagnetically pumped and operated at velocities of 3 to 7 ft/sec. Operating times ranged from 500 to 3000 hr. The major finding of these loop studies was the strong temperature dependence of mass transfer in Inconel (Ni-15% Cr-6% Fe) and Hastelloy alloys (Ni-26% Mo and Ni-26% Mo-5% Cr) at 1000 to 1500°F. In comparative 1000-hr loop tests of Inconel, the formation of macroscopic cold-leg deposits was initially observed at 1300°F, and the extent of deposition increased rapidly with increasing hot-leg temperature. The total weight of deposits at 1500°F showed a linear dependence on both flow rate and temperature difference. Changes in the O_2 concentration of Na from 10 to 500 ppM had little effect on the rate of mass transfer of Inconel. Higher O_2 concentrations increased the mass transfer rate. Loop tests of austenitic stainless steels at 1500 to 1650°F produced much lower mass transfer rates than Ni-base alloys under comparable temperature and purity conditions. In tests of 18-10 stainless steels (types 316, 347, and 304) at 1500°F, only trace quantities of cold-leg deposits were measurable after 1000 hr. Stainless steels with higher Ni concentrations (types 310 and 330) and type 430 stainless steel showed mass transfer rates intermediate between the 18-10 steels and Ni-base alloys. (J.R.D.)

4904 THE HEAT TREATMENT OF ANODIC OXIDE FILMS ON TANTALUM. V. THE THERMAL REDISTRIBUTION OF INCORPORATED PHOSPHORUS. Smyth, D. M. (Sprague Electric Co., North Adams, Mass.). J. Electrochem. Soc., 113: 1271-4 (Dec. 1966).

Dielectric measurements and radiotracer techniques were used to follow the migration of incorporated phosphorus in anodic oxide films on Ta during heat-treatment at temperatures above 400°C. The P moves away from the Ta, accumulating into a region of very high P content on the Ta side of the P-containing layer. Little or no migration occurs on the other side of the layer. Redistribution is much more extensive when heat-treatment was carried out in air than when the ambient was a vacuum. (auth)

4905 PARABOLIC OXIDATION KINETICS OF NIOBIUM. Sheasby, J. S. (Univ. of New South Wales, Kensington); Wallwork, G. R.; Smeltzer, W.W. J. Electrochem. Soc., 113: 1255-7(Dec. 1966).

The rate of growth and properties of the first layer of compact γ-Nb_2O_5 to form are important for elucidation of the oxidation reaction for niobium. It was found possible to maintain this oxide in contact with the metal for sufficient time in the temperature range 720° to 825°C to make measurements of its growth rate at various oxygen pressures. This layer, which accounts for the major proportion of the oxygen uptake during the time of its formation, was found to grow at a parabolic rate by a process in which the dominant diffusing species is oxygen. The growth rate of this oxide was highly sensitive to the environmental pressure of oxygen; but it was not pervious to molecular oxygen. (auth)

4906 STUDIES ON THE OXYGEN GRADIENTS IN OXIDIZING METALS. V. THE OXIDATION OF OXYGEN-SATURATED ZIRCONIUM. Pemsler, J. P. (Kennecott Copper Corp., Lexington, Mass.). J. Electrochem. Soc., 113: 1241-4(Dec. 1966).

Oxygen-saturated Zr was oxidized at temperatures between 840 and 1300°C. In the range 1100° to 1300°C a parabolic film growth rate was observed, which was more rapid than that observed during oxidation of oxygen-free metal. The rational rate constants k_r, which characterize transport properties through the film, were identical. In the range of 840° to 975°C a rapid initial growth was followed by a parabolic rate more rapid than that observed on oxygen-free metal. Values of k_r were somewhat larger for oxidation of oxygen-saturated metal; the difference became greater at higher temperatures. Oxygen solution during oxidation of oxygen-free Zr at 840° to 975°C was believed to result in a more protective film due to the formation of voids within the film. (auth)

4907 STRESS MEASUREMENTS DURING THE OXIDATION OF TANTALUM AND NIOBIUM. Pawel, R. E.; Campbell, J. J. (Oak Ridge National Lab., Tenn.). Acta Met., 14: 1827-33(Dec. 1966). (ORNL-P-2002).

The flexure technique was used to characterize the development of stresses during the gaseous oxidation of Ta at 350 to 550°C and of Nb at 400 and 525°C. Bending stresses in the rectangular specimens were calculated and their presence rationalized on the basis of surface stresses due to both O_2 solution and oxide film effects. In the early stages of oxidation, stresses of the order of the yield stress arise in the surface layers due to the solution of O_2 into the metal. At some later time, as thicker oxide layers develop, film stresses substantially control the gross flexure behavior. (auth)

4908 SPECIAL AQUEOUS CORROSION PROBLEMS CONNECTED WITH NUCLEAR PLANTS. Coriou, H. (CEN, Saclay, France). Bull. Inform. Sci. Tech., No. 107, 3-11(Sept. 1966). (In French).

Nuclear considerations have led to the development of new metals or the use of conventional materials under unusual conditions. The special corrosion problems which arise as a result are examined, and the complexity of the phenomena involved is shown and a number of examples are presented. The problems raised by the circulation and deposition of corrosion products in reactor circuits are discussed, and certain questions relating to spent fuel processing plants are reviewed. (auth)

4909 STUDY OF THE RESISTANCE TO AQUEOUS CORROSION OF LIGHT ALLOYS. Pelras, M. (CEN, Saclay, France). Bull. Inform. Sci. Tech., No. 107, 51-64(Sept. 1966). (In French).

Aluminium and its alloys are used as canning and structural materials in water-cooled reactors. Their resistance to aqueous corrosion is studied at low and at high temperature. Fuel elements canned with magnesium alloys and used in gas-cooled reactors raise corrosion problems during their storage in deactivation tanks. Comparison of the different compositions of magnesium and alloys, the use of corrosion inhibitors, and the influence of chlorides and couples are discussed. (auth)

4910 STUDY OF THE BEHAVIOR OF ZIRCONIUM ALLOYS IN WATER AND SUPERHEATED STEAM. Coriou, H. (CEN, Saclay, France). Bull. Inform. Sci. Tech., No. 107, 37-49(Sept. 1966). (In French).

The resistance to aqueous corrosion of non-alloyed zirconium is studied. It is shown in particular that the resistance of very pure zirconium to hot water (360°C) and especially to superheated steam (400°C) is inferior to that of Kroll commercial zirconium. The corrosion resistance properties of Zircaloy 2 and Zircaloy 4 are reviewed and the influence of irradiation on the corrosion behavior of these alloys is examined. The possibility of using zirconium alloys in superheated steam at temperatures of around 500°C is discussed. (auth)

4911 IS PROCESSING AT 2,000 F NOW POSSIBLE? Martius, U. (Ontario Research Foundation). Can. Chem. Process, 50: No. 11, 71-4(Nov. 1966).

The technology of materials for use at high temperatures is reviewed. Developments in the areas of metals and alloys, coating and cladding, and ceramics are discussed. Surface protection problems are outlined and factors affecting coating life, properties of ceramics, effects of environment on various materials, and radiation effects are examined. (J.R.D.)

4912 THE OXIDATION OF Nb-Zr AND Nb-Zr-Re ALLOYS IN OXYGEN AT 1000 DEG C. Rapp, Robert A.; Goldberg, G. N. (Ohio State Univ., Columbus). Trans. Met. Soc. AIME, 236: 1619-28(Nov. 1966).

The steady-state kinetics and microstructures of simultaneous internal oxidation and external scale formation were investigated for the oxidation of Nb-Zr and Nb-Zr-Re alloys in pure oxygen at 1000°C. For each binary alloy, a constant rate of scale formation was observed at steady state; the internal oxidation zone reached a steady-state, time-independent thickness. The dependence of the scaling rate on Zr content exhibited a maximum at a low Zr content; more concentrated alloys oxidized at a slower rate than pure Nb. This composition dependence of the scaling rate may be partially attributed to the effect of the internal oxidation process as an internal sink for O_2 with the formation of voluminous, and relatively impermeable ZrO_2 precipitates. However, the morphologies of the ZrO_2 internal oxide precipitates also affected the scaling rate. The internal oxide precipitates were distributed uniformly in the external scale. The steady-state thicknesses of the internal oxidation zones were not in agreement with those predicted theoretically from an idealized simple model. However, in this particular alloy system the ideal model is not satisfied experimentally. For ternary Nb-Zr-Re alloys with $N_{Re}^{(0)} = 0.02$ or 0.05, the steady-state thicknesses of the internal oxidation zones were less than those for the corresponding binary Nb-Zr alloys. For ternary alloys with $N_{Re}^{(0)} = 0.05$, a more adherent and much less porous external scale was formed, and a reduction in the kinetics of scale formation was observed. (auth)

Preparation and Fabrication

4913 (AECL-2617) CLADDING THE INSIDE SURFACE OF A $3\frac{1}{4}$ IN. ID ZIRCALOY-2 PRESSURE TUBE WITH 1S ALUMINUM. Watson, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sept. 1966. 19p. (CRE-1215). Dep. mn. AECL $1.00.

A hot-press sizing technique was developed for cladding the inside surface of Zircaloy-2 pressure tubes with 1S Al. The process is performed in air with the Zircaloy-2 and Al at a temperature of approximately 950°F. A controlled atmosphere is not required, either during preheating or while the cladding is being applied. Tubes 30 in. long and $3\frac{1}{4}$ in. ID were coated with 1S Al in thicknesses ranging from 0.005 to more than 0.02 in.; tubes longer than 30 in. were not attempted. The lining of Al is firmly attached to the Zircaloy-2 at all points in the tube but the bond strength varies from 6500 to 28000 lbf/in^2. (auth)

4914 (GEAP-5003) ELECTRON MICROSCOPIC EXAMINATION OF HIGH POWER DENSITY STAINLESS STEEL CLADDING. Wolff, U. E.; Mathay, P. W.; Cowden, W. C. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1966. Contract AT(04-3)-361. 27p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Type-304 stainless steel fuel rod cladding was examined by electron microscopy. The fractures of two failed rods were investigated with replicas from fracture surfaces, and cross sections containing cracks. The fracture features observed were very similar to those found in other type-304 stainless steel cladding. It was concluded that failure occurred by intergranular corrosion. There was no evidence of transcrystalline, stress corrosion. However, it cannot be ruled out that stresses might have assisted in the corrosive attack. The effects of neutron irradiation on the microstructure of two other rods (one cold worked, one annealed) were investigated, and the defect structure was documented with transmission micrographs of thinned metal foils. (auth)

4915 (KAPL-3159) CHEMICAL AND ELECTROCHEMICAL MILLING OF SPIRAL LANDS ON ZIRCALOY TUBING. Lozier, P. G.; Oaks, W. C.; Birnby, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Aug. 15, 1966. Contract W-31-109-eng-52. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work was performed to determine the feasibility of milling spiral lands for spacers on Zircaloy tubing by chemical and electrochemical means. Four spiral integral protrusions (lands) were formed on heavily cold-worked Zircaloy-4 tubing. The lands were 40 mils wide and 7.5 mils high. The tube material between the lands was removed by chemical or electrochemical dissolution. For the chemical dissolution study, the areas of the desired protrusions were masked, and the tubing was then immersed in a pickling solution (HNO_3-HF). Electrochemical milling with use of a saturated solution of NaCl in water and high current density (400 amps/in.^{2}), provided another means of forming the tube to the desired shape and dimensional tolerances. Although large quantities of this tubing were not formed, it was estimated that the electrochemical milling process would be economically feasible. (P.G.C.)

4916 (KAPL-M-6444) USE OF "WHIRLIMET" POLISHING ATTACHMENTS FOR GRINDING METALLOGRAPHIC SAMPLES IN THE REMOTE METALLOGRAPHY FACILITY AT KAPL. Wemple, B. D. (Knolls Atomic Power Lab., Schenectady, N. Y.). Jan. 11, 1965. Contract W-31-109-eng-52. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Grinding of metallographic samples in a metallography cell using Buehler Whirlimet polishing attachments is described. Good results are being obtained in short times with the Whirlimet because of its hot cell operational advantages. Also, because of low modification and purchase costs, the Whirlimet may be initially installed in a hot cell economically. (J.R.D.)

4917 (N-66-29373) VAPOR DEPOSITED TUNGSTEN FOR APPLICATION AS A THERMIONIC EMITTER MATERIAL. Weinberg, A. F.; Lindgren, J. R.; Mills, R. G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 28, 1965. Contract NAS3-6471. 15p. (NASA-CR-67182; GA-6473). CFSTI $3.00 cy, $0.65 mn.

Properties associated with the application of W prepared by the H_2 reduction of WF_6 as a thermionic emitter are discussed. Areas investigated include the quality of material available and the resistance of this material to grain growth. Properties which have been determined during the evaluation program were microstructure, both before and after extensive thermal treatments; ductile-to-brittle transition temperature; impurity content; and hardness. Experimentation has shown that the resistance of vapor-deposited W to grain growth is primarily structure sensitive, and in all cases where grain growth is observed, it starts at regions of marked grain misorientation, primarily a layer of small, equiaxed, randomly oriented grains which extends into deposited material up to 0.003 in. from the substrate surface. If this layer is removed prior to thermal treatment, resistance to grain growth is markedly improved. (auth)

4918 (N-66-29907) INVESTIGATION OF FOAMED METALS FOR LAUNCH AND SPACE VEHICLE APPLICATIONS. Byrnes, Edward R. Jr.; Twine, Charles J. (Ipsen Industries, Inc., Rockford, Ill.). May 1966. Contract NAS8-11048. 131p. (NASA-CR-76061). CFSTI $3.00 cy, $0.65 mn.

Investigations of methods for manufacturing porous metals are reported. Effects of variables in processing and fabrication on the ultimate strength and integrity of foam metals are discussed. The foamed metals studied were Al, Ti, Ni, 316 stainless steel, steel, and Mo. No unusual difficulties were encountered in preparing foam metals of Mo, steel, 316 stainless steel, and Ni; however, at densities less than 15% of theoretical, the foam metals exhibited brittle fracture characteristics. A useable foamed Al was not produced. Ti could be foamed and sintered, but oxide contamination between the grain boundaries resulted in a product with marginal ductility for structural applications. Variable density beams were manufactured wherein the core material was of graduated density through the depth of the beam. The results of mechanical, physical, and thermal property tests are presented. Data concerning the machinability and fabrication techniques of foam metals are included. (auth)

4919 (ORNL-TM-1600) THE FABRICATION OF A POTASSIUM VAPOR RADIATOR FOR THE MEDIUM-POWER REACTOR EXPERIMENT LARGE POTASSIUM SYSTEM. Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A large potassium-condensing radiator was built for use with the Medium-Power Reactor Experiment program K system. The radiator consisted of 96 tapered tubes, each 7 ft long, attached to a complex manifold system which gave the completed unit cylindrical symmetry. The tapered tubes each had three high-conductivity fins attached by welding and brazing procedures specially developed for this work. (auth)

4920 WELDING APPLICATIONS TO NUCLEAR POWER. Dickinson, F. S.; Watkins, B. Weld. Metal Fabr., 34: 204-15 (June 1966).

A survey of welding applications is presented in which examples are discussed to indicate the variety of problems encountered in this field. Included are discussions of welding applications on steel pressure vessels for gas-cooled reactors, Na-cooled systems, Al pressure tubes, chemonuclear processing plants, and fuel element end sealing. (J.R.D.)

4921 THE EFFECT OF FABRICATION VARIABLES ON GRAIN SIZE OF MAGNOX AL80 FUEL CANS. Vaughan, T. B.; Sumner, L. R. Metallurgia, 74: 109-15(Sept. 1966).

The effects of fabrication variables on grain size in a typical Magnox AL80 finned can used for the production of fuel elements intended for the current generation of gas-cooled nuclear reactors were studied. The effects of twisting temperature, degree and speed of twisting, and degree and speed of plugging were derived from two statistically designed experiments. The effects of broaching and the use of higher annealing temperatures were also briefly examined. Tests involving pressurizing on to dummy fuel rods with variable anti-ratcheting groove spacings to simulate pressurizing and annealing treatments normally applied to the cans during fuel element assembly showed that the conditions for producing a satisfactory can are then much more critical. (auth)

4922 GROWTH OF SINGLE CRYSTALS OF ZIRCALOY-2. Nasir, M. J.; Bray, H. J. (John Dalton Coll. of Tech., Manchester, Eng.). J. Inst. Metals, 94: 398-9(Nov. 1966).

Three methods of growing large single crystals of Zircaloy-2 were tried: cycling the specimen between 840 and 1200°C; prolonged annealing in the α phase at 840°C; and heating at 1200°C for $\frac{1}{2}$ hr followed by quenching to room temperature and then annealing at 840°C for 12 days. The results indicated that any successful attempt to grow large grains of Zircaloy-2 must include elimination of the θ phase by quenching or annealing in the α-phase range. (A.G.W.)

4923 INFLUENCE OF THE TRANSFORMATION CONDITIONS FOR ZIRCALOY-2 ON THE STRUCTURE AND MECHANICAL PROPERTIES OF THE FINISHED OR SEMI-FINISHED PRODUCTS. Armand, M.; Givord, J.-P.; Trolliet, G. Mem. Sci. Rev. Met., 63: 747-55(Sept. 1966). (In French).

In order to eliminate surface defects and heterogeneous microstructure, the products subjected to extrusion must have a fine-grained equiaxed α structure, that is to say they must have undergone sufficient workhardening in the α region. In order to obtain sheet with high mechanical properties, the metal must be quenched after the β phase, and the time and temperature of the heat treatment following the quenching must be restricted. (auth)

4924 X-RAY-DIFFRACTION STUDY OF THE PERFECTION OF NIOBIUM (COLUMBIUM) SINGLE CRYSTALS. Achter, M. R.; Vold, C. L.; Digges, T. G. Jr. (Naval Research Lab., Washington, D. C.). Trans. Met. Soc. AIME, 236: 1597-1605 (Nov. 1966).

A study was made of the effect of the growth conditions on the perfection of single crystals of Nb. Dislocation densities, determined by means of double-crystal diffractometer measurements, were not greatly affected by the method of crystal preparation but could be reduced by annealing treatments. However, the size, sharpness, and tilt angles of the substructures, observed with x-ray-reflection micrographs, were sensitive to variations in growth procedures as well as to subsequent thermal treatments. Although the dislocation density was the same in both types, there were more low-angle boundaries in crystals grown by zone melting than in those prepared by strain anneal. Mechanisms to account for these observations are discussed in terms of dislocation movements. (auth)

4925 PRODUCTION OF BERYLLIUM ALLOYS. Sibert, Merle E.; Hultquist, Arnold E. (Lockheed Palo Alto Research Lab., Calif.). J. Metals, 18: 1215-22(Nov. 1966).

Production techniques for Be by Al reduction of Be compounds; electrolytic reduction of Be compounds; electrorefining crude Be ore; and electrolytic co-deposition of Be and Al are evaluated. It was concluded that an electrolytic process using a soluble Be scrap anode and a liquid Al cathode shows the most promise. (J.R.D.)

4926 OPERATING COST OPTIMIZATION OF THE LD PROCESS. Dittman, Frank W. (Rutgers State Univ., New Brunswick, N. J.). J. Metals, 18: 1209-14(Nov. 1966).

Discussions concerning cost optimization of an existing LD (process using 99.5% O_2 impinging on molten mixture of pig and scrap Fe) plant are presented. Only variables which can be changed independently in a prescribed pattern under operator control are considered. Discussions are included concerning the effects of ingot yield on production cost, effects of changes in production tons/heat on unit cost, effects of changes in tap-to-tap time on unit cost, and effects of heats/yr on unit cost. The optimization method is outlined along with calculation methods. (J.R.D.)

4927 BERYLLIUM TECHNOLOGY. VOLUME 1. CONFERENCE SESSIONS 1-4. Proceedings of the Second International Conference, Philadelphia, Pennsylvania, October 15–17, 1964. Schetky, L. McDonald; Johnson, Henry A. (eds.). Metallurgical Society Conferences. Volume 33. New York, Gordon and Breach, 1966. 690p. $19.00 paper; $35.00 cloth. (CONF-729–(Vol.1)).

Thirty-three articles on the purification and alloying and physical and mechanical metallurgy of Be are included. (P.C.H.)

4928 HIGH TEMPERATURE ISOSTATIC PRESSING. Ballard, A. H.; Hendricks, R. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,279,917. Oct. 18, 1966.

An invention relating to a method of forming articles from powders by a high temperature isostatic pressing technique is described. In accordance with this method pressure is transmitted to a powder mass from a solid particulate isostatic pressure transmitting medium through a flexible membrane comprising a material which decomposes at a temperature lower than the sintering temperature of the powder mass. (auth)

Properties Evaluations

Refer also to abstracts 4923 and 4927.

4929 (AD–637162) THE EFFECT OF $AlFeBe_4$ ON MECHANICAL PROPERTIES OF FABRICATED POLYCRYSTALLINE BERYLLIUM. Carrabine, J. A.; Woodard, D. H.; Stonehouse, A. J.; Beaver, W. W. (Brush Beryllium Co., Cleveland, Ohio). 1964. 23p. (TR–368). CFSTI $3.00 cy, $0.65 mn.

Study showed the AlFeBe4 reaction to be reversible, the dissolution of the phase being accompanied by an increase in free Al, with reasonable evidence for Fe being in solid solution. Both room- and high-temperature strengths were strongly dependent on the reaction; strength increased with excess Fe, i.e., iron not combined as AlFeBe4. Room-temperature ductility showed no consistent dependence on phase behavior; however, high-temperature ductility varied considerably with Fe and Al contents. In general, optimum ductilities corresponded to Fe/Al weight ratios of two or greater and/or low Al contents. Aging generally lowered strength properties at all temperatures and had little effect on room-temperature ductility. On the other hand, aging increased elevated-temperature ductility in all cases tested. (auth)

4930 (AECL-2622) THE EFFECT OF HYDROGEN ON THE FRACTURE TOUGHNESS OF ZIRCALOY-2 AND ZIRCONIUM-2.5 PERCENT NIOBIUM. Parry, G. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Aug. 1966. 23p. Dep. mn. AECL $1.00.

The effect of hydrogen on the plane strain fracture toughness of single edge notch specimens from Zircaloy-2 and Zr-2.5% Nb pressure tubes was determined by crack opening displacement measurements and by application of linear elastic fracture mechanics. It is shown that hydrogen lowers the room temperature fracture toughness and critical crack lengths of the materials, whereas at 300°C Zircaloy-2 is unaffected by H_2 concentrations up to 500 ppm. Hydride layers at the notch tip greatly reduce the room temperature fracture toughness of Zircaloy-2. The critical crack opening displacement approach does not obey the stress vs. $\delta^{1/2}$ theoretical straight line relationship at H_2 concentrations below 400 ppm, while gross yielding at the notch tip makes the linear elastic treatment invalid below 500 ppm H_2. It was concluded that the single edge notch specimen is suitable for fracture toughness measurements of Zircaloy-2 and Zr-2.5% Nb within these limitations. (auth)

4931 (LA–3594) THE SOLUBILITIES OF SELECTED ELEMENTS IN LIQUID PLUTONIUM. IX. VANADIUM. Bowersox, D. F.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). Sept. 15, 1966. Contract W-7405-eng-36. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The solubility of V in liquid Pu was measured over the temperature range from 700 to 1000°C. The solubility increased from 0.22% V (by weight) at 700°C to 0.98% V at 1000°C. The data fit the equation $\log N_V = 0.804 - 2.74 \times 10^3\ T^{-1}$, where N_V is the solubility expressed as the mole fraction and T is the temperature in degrees Kelvin. (auth)

4932 (LA-DC–8136) MAGNETIC PROPERTIES OF $PrAl_2$. Olsen, C. E.; Arnold, G.; Nereson, N. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 6p. (CONF-661107–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 12th Annual Conference on Magnetism, Magnetic Materials, and Exhibits, Washington, D. C.

Neutron diffraction powder patterns confirmed that the compound $PrAl_2$ undergoes a magnetic transition to a ferromagnetic structure at a Curie temperature of 38°K. The ordered moment at saturation on the Pr atom sites is $2.94 \pm 0.05\ \mu_B$, which is close to the full moment of $3.2\ \mu_B$ expected for the free Pr^{+3} ion. No detectable moment is observed for Al. The results for the total moment per molecule are in satisfactory agreement with previous magnetization measurements. The shape of the magnetic form factor for the Pr^{+3} ion was determined over the range from $(\sin\theta)/\lambda = 0.1\ Å^{-1}$ to $0.5\ Å^{-1}$ and is in good agreement with calculated values. (auth)

4933 (N–66-29081) S-N CHARACTERISTICS OF NOTCHED SPECIMENS. Final Report. Smith, Clarence R. (General Dynamics/Convair, San Diego, Calif.). June 15, 1966. Contract NAS3-7268. 45p. (NASA-CR–54503). CFSTI $3.00 cy, $0.65 mn.

Fatigue test data and analyses are presented indicating that the results of a single fatigue test in the short life range plus mechanical properties of the material are all that is needed to predict S-N (stress-number) characteristics of notched specimens for tension–tension loading. Independent of nominal stress or stress concentration, the method is applicable to structural parts where neither average stresses nor stress concentrations are known. While confirmed by tests on 7075-T6 Al alloy only, the method should be applicable to most alloys having a low sensitivity to strain hardening or softening. (auth)

4934 (N-66-29866) EFFECT OF ORIENTATION ON FRICTION CHARACTERISTICS OF SINGLE-CRYSTAL BERYLLIUM IN VACUUM (10^{-10} TORR). Buckley, Donald H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1966. 20p. (NASA-TN-D-3485). CFSTI $3.00 cy, $0.65 mn.

Studies were conducted to determine the effects of the crystallographic orientation of single-crystal Be on its friction characteristics when in sliding contact with sapphire and polycrystalline Be and Al_2O_3. Experiments were conducted in a vacuum of 10^{-10} torr with a $^{5}/_{16}$-in. hemispherical-radius Be crystal sliding on a flat of Be and Al_2O_3. The rider was loaded against the flat with various loads from 100 to 1500 g and the flat disk was rotated to give a sliding speed of 0.013 cm/sec. The results of the investigation showed that the basal plane exhibited lower friction than the prismatic slip plane. With the basal plane parallel to the interface, lower friction coefficients were observed in the $\langle 11\bar{2}0 \rangle$ than in the $\langle 10\bar{1}0 \rangle$ directions. The lowest friction coefficient for basal orientation was obtained with the basal plane inclined 135° to the sliding interface. The friction coefficient of single-crystal Be sliding on sapphire was lower than that of single-crystal Be sliding on polycrystalline Al_2O_3. With sapphire, brittle fracture of sapphire was observed, while with polycrystalline Al_2O_3, shear of Be was observed. (auth)

4935 (N-66-29978) CREEP AT ELEVATED TEMPERATURES AND HIGH VACUUM. Semiannual Report No. 4. Schroder, K.; Giannuzzi, A.; Gorsha, G. (Syracuse Univ. Research Inst., N. Y. Dept. of Chemical Engineering and Metallurgy). May 1966. 26p. (NASA-CR-76088; SURI-MET-E-1189-566-SA). CFSTI $3.00 cy, $0.65 mn.

A series of high-purity Cu wires were creep tested in a high vacuum at 785 to 855°C. They were tested in both the Ar-bombarded, clean state, and after oxidizing in air at these elevated temperatures. It was found that the creep rate of the sample decreased noticeably after oxidation for about one hr at 400 to 500°C. The sample fractures in the oxidized state in tests above 835°C. The largest minimum creep rate of the Ar-bombarded, clean sample was about 0.1%/min whereas the largest minimum creep rate for the oxidized sample under the same stress of about 850 g/cm^2 was less than 0.02%/min. It is proposed that the creep phenomena can be explained with a model in which oxide films act as dislocation barriers for dislocation. Further experiments are required to elucidate this mechanism and the fracture process. (auth)

4936 (N-66-30539) APOLLO SERVICE MODULE REACTION CONTROL SYSTEM ENGINE CHAMBER SEAL STUDY. Materials Report. Puntar, J. (Marquardt Corp., Van Nuys, Calif.). [1966]. Contract NAS9-4775. 83p. (NASA-CR-65420; MR-3008-F). CFSTI $3.00 cy, $0.65 mn.

Metallic and nonmetallic materials with low thermal conductivities and high strength are evaluated for possible use in high thermal resistance injector head-combustion chamber seals for the Apollo service module. Test procedures to determine structural properties, compressive strengths, and failure modes are summarized for small scale specimens of Ti alloy, Rene 41, a Co-base alloy (20% cold worked), and for three grades of ZrO_2. Data analyses show that sufficient safety margins were attained with these materials in combination with the desilicide coated Mo combustion chamber material. Thermal resistance measurements were also made on seal configurations including conical thinwall, straight thinwall, and composite (with ZrO_2 spacers); Ti and Rene 41 seals were used. Test results and data summary sheets are included. Further thermal evaluation was conducted on experimental ZrO_2 materials; results indicate that the materials are not suitable for use as spacers in the composite seal design. (auth)

4937 (N-66-32186) INVESTIGATION OF TWO-PHASE TUNGSTEN-RHENIUM ALLOYS FOR IONIZER APPLICATIONS. VOLUME II. Final Report. Kirkpatrick, M. E.; Mendelson, R. A. (TRW Systems, Redondo Beach, Calif.). July 1966. Contract NAS3-7109. 33p. (NASA-CR-54694; TRW-4429-6012-RO-000(Vol.2)). CFSTI $3.00 cy, $0.65 mn.

The development of porous materials from a cast two-phase alloy of W-Re was investigated with regard to its suitability and applicability to porous ionizer materials. The laboratory program involved a study of the microstructure as a function of alloy composition over the range from 25 to 45 wt % Re. It was demonstrated that alloys in the range from 36 to 38 wt % Re had optimum proportion and configuration of the W solid solution and the sigma-phase alloy components. An extensive investigation into phase removal techniques for removing the sigma-phase component are reported and indicate an electrolytic etching technique to be optimum in terms of reproducibility and efficiency. Cesium ionization tests were performed using a button-shaped emitter with a diameter of approximately 1/8 inch. The ionizer test results are discussed. (auth)

4938 (NASA-SP-131, pp 169-99) POTASSIUM RANKINE SYSTEM MATERIALS TECHNOLOGY. Rosenblum, Louis; Englund, David R. Jr.; Hall, Robert W.; Moss, Thomas A.; Scheuermann, Coulson (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

A discussion of the materials technology for advanced Rankine cycle systems as concerns the working fluid, potassium, and the containment materials, alloys of the refractory metals niobium and tantalum, is presented. Some of the problems inherent in the application of these materials to space power systems are presented, and the more significant results of recent materials investigations are summarized. (F.S.)

4939 (ORNL-P-2703) THERMAL FATIGUE ANALYSIS OF A CRYOGENICALLY COOLED ROCKET NOZZLE. Carden, A. E.; Harman, D. G.; Franco-Ferreira, E. A. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 16p. (CONF-661204-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Astronautical Society, Southeastern Symposium in Missiles and Aerospace Vehicles Sciences, Huntsville, Ala.

It is noted that thermal fatigue can be a serious problem for the coolant tubes of regeneratively cooled rocket nozzles. A laboratory test was devised which provides thermal conditions similar to those in nozzle service. This test was capable of producing tube failure in substantially less than 100 thermal cycles. Thus, the principles of similitude and modeling appear to be appropriate for the examination or determination of low-cycle fatigue characteristics of large complex structures. Increasing high-temperature hold times, up to 5 min, and dents in the tubes appreciably curtail the fatigue life. (auth)

4940 (ORNL-TM-1436(Rev.)) AN APPROXIMATE METHOD FOR DETERMINING ALLOWABLE STRESS RATES FOR CAPSULES CONTAINING HELIUM-PRODUCING ISOTOPES. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method was devised for calculating failure times under certain conditions of predictably varying stress and temperature from conventional creep data. A computer program was written for making the associated calculations and plotting the resulting curves. A sample set of data was used to verify the workability of the program. Within certain limitations, this method can be used to predict the mechanical performance of isotope-containing capsules from conventional mechanical property data. (auth)

4941 (UCRL-17090) THE MECHANISM OF BASAL CREEP IN Mg-12 ATOMIC PERCENT Li. Chirouze, Bernard Yves (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 9, 1966. Contract W-7405-eng-48. 16p. DTIE.

Thesis.

The effect of changes in stress and temperature on the creep rate of single hexagonal crystals of Mg-12 at. % Li alloy, oriented for basal glide in simple shear by the $\{0001\}$ $[1\bar{2}10]$ mode of slip, was determined at 500 to 830°K. From 600 to about 750°K, the specimens, after a primary stage of short duration, entered secondary creep for which: $\dot{\gamma} = 1.6 \times 10^{-28} \tau^{4.9} e(-37{,}000/RT)$, where $\dot{\gamma}$ is the shear strain rate per second, τ is the stress in $dynes/cm^2$, R is the gas constant, and T is the absolute temperature. The results suggest that basal creep in this alloy, at 600 to 750°K, is controlled by the dislocation climb mechanism. For temperatures less than or equal to 550°K the strain rate was found to increase very rapidly with the stress. Microscopic examination of the gage sections of the specimens showed that twinning occurred in this temperature range. For temperatures greater than 800°K, the activation energy was found to increase substantially, indicating that some new mechanism becomes operative as the specimens approach the melting temperature. (auth)

4942 (WAPD-T-1831) STRAIN CYCLE FATIGUE OF K-MONEL. Gibbons, W. G. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1965. Contract AT(11-1)-Gen-14; NObs-90029. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The results from strain-cycled fatigue tests on four varied material conditions of age-hardened K-Monel are presented. The fatigue failure curve is independent of the material condition. A fatigue failure curve for K-Monel is presented that is suitable for design and analysis purposes. (auth)

4943 SUPERCONDUCTING NIOBIUM STANNIDE (Nb_3Sn) FILMS ON METALLIC SUBSTRATES. Chu, T. L.; Gavaler, J. R. (Westinghouse Research Labs., Pittsburgh). J. Electrochem. Soc., 113: 1289-92(Dec. 1966).

Nb_3Sn was transported from a sintered source material onto various substrates by hydrogen halides in the presence of a temperature gradient. The superconducting transition temperature of the deposited films was found to depend, among other factors, strongly on the separation between the source and the substrate. At large separations, the deposited films were nonstoichiometric due to the differences in reactivities of Nb and Sn toward hydrogen halide and the ease of reduction of Nb and Sn halides with H_2. At small separations, the films deposited on metallic substrates were found to have a superconducting transition temperature of 18°K and a critical current density of up to 6×10^4 amp cm^{-2} in magnetic fields of 50 kG. (auth)

4944 EVALUATION OF VARIOUS EQUATIONS FOR EXPRESSING FIRST-STAGE CREEP BEHAVIOR. Conway, J. B.; Mullikin, M. J. (General Electric Co., Cincinnati). Trans. Met. Soc. AIME, 236: 1496-1501(Oct. 1966).

Equation forms were studied to determine the extent to which each particular equation type yields accurate representations of specific sets of first-stage creep data. Specially developed least-squares computer programs were employed to obtain unique solutions for the creep-equation constants. In studies of creep data for Pb at 14.5°C, Ni at 700°C, and arc-cast W at 2400°C consistently good representations were afforded by a third-degree polynomial in $t^{1/3}$. Other effective correlations were obtained with the Andrade, Cottrell–Aytekin, and de Lacombe equations along with a third-degree polynomial $t^{1/3}$. A newly proposed creep equation involving a hyperbolic-sine term in $t^{1/3}$ was also found to yield very satisfactory results. This appears to be the first use of such a functional relationship in the analysis of transient creep behavior. (auth)

4945 ANOMALOUS DIFFUSION BEHAVIOR OF BCC ZIRCONIUM. Tiwari, G. P.; Sharma, B. D. (Atomic Energy Establishment, Trombay, India). Acta Met., 15: 155-7(Jan. 1967).

The suggestions to explain the curvature of the ln D vs 1/T plot for diffusion in β-Zr are criticized, in particular Kidson's idea of thermal and extrinsic vacancies. The impurity diffusion data for β-Zr are reviewed, and it is shown that extrinsic vacancies should enhance impurity diffusion as well as self-diffusion. A plot of ΔS vs log T is linear, showing the continuous variation of the entropy and activation energy to be real. It is suggested that the metals β-Hf, γ-U, and β-Zr are cases where the melting point is not a true index of the bond strength. Some possible reasons for their stability at higher temperatures are discussed. (D.L.C.)

4946 LOW-TEMPERATURE SPECIFIC HEAT OF TRANSITION METALS AND ALLOYS. Heiniger, F.; Bucher, E.; Muller, J. (Univ. of Geneva). Phys. Kondens. Mater., 5: 243-84(1966).

Experimental results are reviewed on the low-temperature specific heat of the transition metals and their alloys. Particularly discussed are the variations of the electronic part on the basis of a complete compilation of measurements given. 190 references. (auth)

4947 ELECTRONIC SPECIFIC HEAT AND ANTIFERROMAGNETISM IN CHROMIUM ALLOYS. Heiniger, F. (Univ. of Geneva). Phys. Kondens. Mater., 5: 285-301(1966). (In German).

The specific heats of 20 alloys of Cr with Mo, W, V, Ru, and Os within the range of the body-centered cubic phase were measured between 1.5 and 4.2°K and separated in their electronic and lattice parts. From the temperature dependence of the electrical resistance between 70 and 340°K the Néel temperatures of Cr alloys with 0 to 16 at. % Mo could be determined. A comparison of the electronic specific heats and the Néel temperatures of the investigated Cr alloys reveals a considerable reduction of the electronic density of states within the range of concentrations with high Néel temperatures. 51 references. (auth)

4948 EFFECT OF ALLOYING ON TANTALUM–NIOBIUM ALLOY ELECTRIC RESISTANCE. Levin, A. M.; Zhorova, L. P.; Elmanovich, V. N. Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 4, 117-20(1966). (In Russian).

Effects of additional alloying on the specific electric conductivity of Ta–Nb (30 to 35% Nb) were studied using 1 to 10% Re, 2 to 5% Mo, 2 to 10% V, 5 to 20% Zr, and 5 to 20% Ti. The results revealed that small additions of Re, Mo, and V (to 5%) considerably improve the specific electric conductivity and reduce the thermal coefficient of electric resistance (at 20 to 1500°C) of Ta–Nb (33% Nb) without inhibiting the plasticity of the alloy. (R.V.J.)

4949 BERYLLIUM TECHNOLOGY. VOLUME 2. CONFERENCE SESSIONS 5-6. Proceedings of the Second International Conference, Philadelphia, Pennsylvania, October 15–17, 1964. Schetky, L. McDonald; Johnson, Henry A. (eds.). Metallurgical Society Conferences. Volume 33. New York, Gordon and Breach, 1966. 590p. $19.00 paper; $35.00 cloth. (CONF-729–(Vol.2)).

Nineteen articles on mechanical and process metallurgy and design and application of Be structures are included. (P.C.H.)

Structure and Phase Studies

Refer also to abstracts 4536 and 4949.

4950 (AERE-R-5269(Vol.1)) THE NATURE OF SMALL DEFECT CLUSTERS. Volume I of Report of a Consultants Symposium held at A.E.R.E., Harwell, July 4–6, 1966. Makin, M. J. (ed.) (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 304p. (CONF–660715(Vol.1)). Dep. BIS $9.60. HMSO 48s. 0d.

Information is presented from sessions on nucleation of clusters, and aspects of cluster characteristics including theory, results of experimental studies, and neutron scattering experiments. (J.R.D.)

4951 (AERE-R–5269(Vol.2)) THE NATURE OF SMALL DEFECT CLUSTERS. Volume 2 of Report of a Consultants Symposium held at A.E.R.E., Harwell, July 4–6, 1966. Makin, M. J. (ed.) (Atomic Energy Research Establishment, Harwell (England)). 1966. 288p. (CONF–660715(Vol.2)). Dep. BIS $9.60. HMSO 48s. 0d.

Information is presented from a session on aspects of cluster characteristics as determined by electron microscopy, and a session on effects of clusters on mechanical properties. (J.R.D.)

4952 (LA–3584) RAPID QUENCHING DROP SMASHER. Harbur, D. R.; Anderson, J. W.; Maraman, W. J. (Los Alamos Scientific Lab., N. Mex.). July 1966. Contract W-7405-eng-36. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A device for rapidly quenching liquid metals into thin platelets was developed and is built around the technique of catching a molten drop of metal between a rapidly closing plate and a stationary plate. The closing speed of the smasher plate at impact is 12.6 ft/sec. The quenching rate for this device is controlled by the interface resistance between the plates and the platelet, and is dependent upon the heat content and density of the material being quenched. The initial quenching rate down to the freezing point of the platelet material is 10^5 to 10^6°C/sec. After an isothermal delay, which is proportional to the heat of fusion of the platelet material, the final cooling rate down to the temperature of the smasher plates is 10^4 to 10^5°C/sec. (auth)

4953 (N–66-32430) STRUCTURE OF DI-VALENT AND TRIVALENT METALS. Heine, V.; Weaire, D. (Chicago Univ., Ill. Dept. of Physics). [1966]. 48p. (NASA-CR–76750). CFSTI $3.00 cy, $0.65 mn.

The structures of the di- and trivalent metals Be to Hg and Al to Tl are considered from a fundamental point of view, based on the pseudopotential and second order perturbation theory. The most significant factors for the structure of a simple metal are the valence and the position, q_0, of the first zero of the pseudopotential. The q_0 in turn can be related to atomic properties such as the radius of the ion core and the sp promotion energy. When q_0 falls near a set of reciprocal lattice vectors, distortions from a simple structure are likely to occur. The variation of q_0 through the periodic table gives a qualitative explanation of the variation of c/a ratio from Be to Cd; the occurrence of distorted structures in Hg, Ga, and In; and the behavior of the In–Pb and In–Sn solid solution alloys, as well as features of the molten metals and some other elements. (auth)

4954 (ORNL-P–2375) MICROSTRUCTURAL DISCRIMINATION BY DEPOSITION OF SURFACE FILMS. Stiegler, J. O.; Gray, R. J. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 10p. (CONF-660518–9). DTIE.

From AEC Annual Metallography Meeting, Denver, Colo.

Surface films of uniform thickness deposited by vacuum evaporation distinguish different phases due to an optical phase shift at surface film-metal interface that depends on the optical constants of the film and the underlying metal. Experimental details for employing this technique, called deposition etching, are given, along with some examples of the use of the technique in resolving fine structures and in determining the amounts and distributions of phases. (J.R.D.)

4955 (UCRL–16907) ANNEALING OF DISLOCATION LOOPS IN ALUMINUM. Tartour, Jean-Pierre (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1966. Contract W-7405-eng-48. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The change in shape after annealing of Frank loops in quenched 99.999% pure Al was studied by electron microscopy. The loops are found to get roundish at the corners. The process continues until the loops become perfectly round, then they shrink as such upon further annealing. The activation energy for the rounding process is found to be 0.8 eV ± 0.2 eV, suggesting that some short circuit diffusion takes place. A model is proposed according to which the process should be controlled by the creation of bound vacancies at the preexisting well-formed jogs. (auth)

4956 THE STRUCTURAL CHANGES IN THE SYSTEM Ni–Cr–Ti–Al–W AT A TEMPERATURE OF 850 DEG C. Havalda, A. (Laboratoire de la Physique des Metaux, Academie des Sciences, Bratislava). Metaux (Corros.-Ind.), 41: 225-34(June 1966). (In French).

The system Ni–Cr–Ti–Al–W was studied at 850°C. Microscopic and radiocrystallographic methods made it possible to analyze the phases present after anneal up to equilibrium at 850°C in the case of three series of alloys such that Ti/Al < 1, Ti–Al = 1, and Ti/Al > 1, with different W concentrations between 0 and 15 at. %. The results are tabulated and show that in addition to the γ-prime and η phases of the solid solution of Ni, there is an

α phase in the system (solid solution with W base) that is stable at 850°C. The phase Ni_4W was not observed at this temperature. The solubility of W in the solid solution of Ni for the three series of alloys is approximately 8 at. %. By point analysis with the electronic probe it was determined that the solubility of Ni in the α phase is 2 wt %. Microscopic studies showed that W has a great influence on the morphology of the γ-prime phase. In the alloys where Ti/Al = 1 the γ-prime phase is, for low W concentrations, in the cubic form and evolves by progressive increase of the W concentration toward a spheroidal form. In alloys with high Al concentrations Ti/Al < 1 the effect of the W concentration on the morphology of the precipitated particles is negligible. (tr-auth)

4957 THE TERNARY SYSTEM PLUTONIUM–CERIUM–COBALT. Ellinger, F. H.; Land, C. C.; Johnson, K. A.; Struebing, V. O. (Los Alamos Scientific Lab., N. Mex.). Trans. Met. Soc. AIME, 236: 1577-88(Nov. 1966). (LA-DC-7850).

The system Pu–Ce–(Pu,Ce)Co_2 has been investigated by thermal, micrographic, and x-ray-diffraction methods. The principal characteristics of this system were found to be: (1) a "eutectic" valley extending across the phase diagram from the δ Pu/Pu_3Co eutectic at 408°C to the γ Ce/$Ce_{24}Co_{11}$ eutectic at 422°C, the maximum temperature in the valley being 443°C; (2) three ternary intermediate phases, each having an appreciable mutual solid solubility for Pu and Ce; (3) eleven four-phase equilibria comprising one eutectic, four peritectics, and six Class-II reactions; (4) a pseudobinary section between the ternary phase A and the γ Ce solid solution, another such section between the δ Pu solid solution and the η phase (Pu_3Co) containing Ce in solid solution. (auth)

4958 A SURVEY OF DECOMPOSITION PROCESSES IN SUPERSATURATED Fe–27 AT. PERCENT Be. Davies, R. G.; Richman, R. H. (Ford Motor Co., Dearborn, Mich.). Trans. Met. Soc. AIME, 236: 1551-7(Nov. 1966).

Several techniques, x-ray-diffraction, transmission electron microscopy, conventional metallography, and mechanical-property measurements are combined to investigate decomposition in the supersaturated solid solution Fe–27 at. % Be. The following sequence of structures for aging temperatures below 400°C is established: massive short-range order, pseudo-FeBe ($L2_0$) order, Fe_3Be ($D0_3$) order, sinusoidal modulation of composition, general or continuous precipitation, and discontinuous or cellular precipitation. In addition to this sequence itself, several features of the individual stages are noteworthy; for example, when coherent modulations occur, their development is parallel to {100} everywhere in the specimen apparently without incubation, and both the wavelength and the composition amplitude of the modulations increase with aging time. Two types of discontinuous reaction are observed, depending upon the aging temperature. At low temperatures (<550°C) the boundary-nucleated variety of discontinuous precipitate predominates; but at higher temperatures (>600°C) the crystallographic variety occurs instead. Hardness and flow-stress measurements clearly reflect the quoted structure sequence. Some qualitative aspects of the structure changes and of the relationship between mechanical properties and structure are discussed. (auth)

4959 THERMODIFFUSION IN THE SYSTEM UO_2–CeO_2. Beisswenger, H.; Bober, M.; Schumacher, G. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 21: 38-52(1966). (In German).

Investigations of thermal diffusion of CeO_2 in UO_2 are reported. Equipment is described in which cylindrical samples can be annealed at 1400 to 2200°C. The CeO_2 concentrations in the samples were 3.7, 5.6, and 13.3 wt. %. The distribution of CeO_2 after the annealing procedure was analyzed by means of an electron microprobe unit. It was established that the CeO_2 migrates to the higher temperature by a thermal diffusion process. Thus, the CeO_2 concentration decreases in the lower temperature range and increases in the higher temperature range. After annealing some days a minimum of CeO_2 concentration was found at 1700°C and a maximum at 2000°C. At the upper end of the sample the CeO_2 concentration decreased because of a CeO_2 release to the surrounding volume. An electronic computer was used to calculate the concentration course. The results of the calculations, at a concentration of 13.3 wt % CeO_2 and a temperature of 2050°C, were: diffusion coefficient $D = 5.4 \times 10^{-8}$ cm^2/sec, thermal diffusion coefficient $D' = 1.6 \times 10^{-10}$ cm^2/sec/°K, and activation energy Q = 110 kcal/mol. (auth)

4960 THE PHASE DIAGRAMS OF THE RARE EARTH–MERCURY SYSTEMS. Kirchmayr, Hans Rudolf; Lugscheider, Walter (Technische Hochschule, Vienna). Z. Metallk., 57: 725-8(Oct. 1966). (In German).

Investigations by differential thermal analysis on amalgams of the rare earth (RE) metals yttrium, lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, dysprosium, holmium, and erbium are reported. The respective RE–Hg phase diagrams are given, which are based on the measured temperatures of decomposition of the compounds $REHg_4$, $REHg_3$, $REHg_2$, and REHg. The principal differences between measurements of the equilibrium temperatures of decomposition by means of static resp. dynamic methods are discussed. (auth)

4961 CRYSTALLINE STRUCTURES OF THE INTERMETALLIC COMPOUNDS T_2Co_7 AND TCo_3 (T = RARE EARTH OR Y). Bertaut, E. F.; Lemaire, R.; Schweizer, J. (CEN, Grenoble, France. CNRS, Grenoble, France). Bull. Soc. Franc. Mineral. Crist., 88: 580-5(Oct.-Dec. 1965). (In French).

The structures of the compounds T_2Co_7 and TCo_3 (T being a rare earth element or Y), crystallizing in the rhombohedric group $R\bar{3}m$, were established by x rays. They are directly connected to the structure of TCo_5. It was found that the compound TCo_4 does not exist as it is in fact a mixture of TCo_5 and T_2Co_7. The crystalline parameters of different isotope compounds were measured. (tr-auth)

4962 ON THE PROCESS OF PRECIPITATION IN Cu–Be 25 ALLOY. Henmi, Zenzo; Nagai, Takeshi (Fujitsu Labs., Kawasaki, Japan). Nippon Kinzoku Gakkaishi, 30: 857-62 (1966). (In Japanese).

The process of precipitation in Cu–Be 25 alloy was examined by the transmission electron microscope. The aging sequence of Cu–Be 25 alloy is the same as Cu–2% Be alloy, $\alpha \rightarrow$ G.P. zone $\rightarrow \gamma' \rightarrow \gamma$ in grain and $\alpha \rightarrow \gamma$ at grain boundary, but the aging sequence of Cu–Be 25 alloy is slower than Cu–2% Be alloy. The detail of aging sequence is different, for example, the products of the grain boundary reaction has internal stress or the overaged Cu–Be 25 alloy has an anomalous electron diffraction pattern. (auth)

4963 STRUCTURE OF URANIUM–MANGANESE–ALUMINUM–IRON ALLOYS WITH CONSTANT IRON CONTENT OF 10 AT. PERCENT. Petzow, Guenter (Max-Planck-Institut fuer Metallforschung, Stuttgart); Sampaio, A. Oliveira. Z. Metallk., 57: 741-6(Oct. 1966). (In German).

Previous investigations of the system U–UMn_2–UAl_2–UFe_2 have been continued. The quaternary partial system has been established for a constant iron content of 10 at. % by structural examination and thermal analysis. Planes of primary crystallization and the course of the grooves of double saturation were determined. Furthermore, isothermal sections for 800, 725, 700, and 550°C as well as temperature–concentration diagrams have been worked out. The constitution of the alloy examined is relatively complicated above 590°C so that small variations of composition and in heat treatment cause essential property changes. Homogeneity zones of crystals occurring in the respective binary systems are extremely narrow in quaternary ranges. (auth)

4964 DEGASSING KINETICS OF METAL–NITROGEN SOLID SOLUTIONS. II. STUDIES IN THE SYSTEM NIOBIUM–NITROGEN. Hoerz, Gerhard; Gebhardt, Erich (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 57: 737-40(Oct. 1966). (In German).

The degassing kinetics of Nb–N solid solutions were determined by annealing in high vacuum between 1630 and 1790°C. Nitrogenated Nb wires of 0.5 mm dia, containing about 3 at. % N, were resistance heated by dc. Continuous resistance measurements during annealing served to follow the degassing process. For that purpose, the pressure in the receiver was also measured. The degassing of nitrogenated Nb wires has been investigated also at appreciably throttled pumping power at temperatures between 1740 and 2160°C. During these investigations, the degassing time dependency of the receiver pressure was checked. (auth)

4965 THE PHASE DIAGRAM OF THE ERBIUM–COBALT SYSTEM. Buschow, K. H. J. (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Z. Metallk., 57: 728-31(Oct. 1966). (In German).

The system erbium–cobalt was investigated over the whole concentration range by means of microscopical, thermoanalytical, and x-ray diffractional methods. The existence of the following compounds was shown: Er_3Co, Er_2Co, $ErCo_2$, $ErCo_3$, Er_2Co_7, $Er_{0.86}Co_{5.14}$, and Er_2Co_{17}. Except for Er_2Co, the type of structure and the lattice parameters for these compounds are given. The results obtained are gathered in a tentative phase diagram. A comparison is made with other rare earth–cobalt systems. The structure and lattice constants for Y_3Co and Gd_3Co are given. (auth)

4966 THE SOLUBILITY OF CARBON IN MOLYBDENUM, TUNGSTEN, AND RHENIUM. Gebhardt, Erich; Fromm, Eckehard; Roy, Upendra (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 57: 732-6(Oct. 1966). (In German).

The solubility of C in Mo, W, and Re was determined with the isothermal carburizing method. In the Re–C system, no carbide layer was, as expected, found on the sample surface. The maximum solubility of C at the eutectic temperature amounts to 1.1 at. % C in Mo (T = 2180°C), 0.7 at. % C in W (T = 2710°C), and 4.9 at. % in Re (T = 2450°C). With Mo and W, the solubility of C exceeds the values previously found with the usual methods of constitutional research on quenched samples. The maximum solubility of C found for Re is lower than the formerly reported value of 11.9 at. % C. The eutectic temperature of the three-phase equilibrium ($\alpha + \beta + S$) for Mo, W, and Re was determined by melting experiments and compared with the values taken from literature. (auth)

4967 CONTRIBUTION TO THE STUDY OF THE INHIBITION OF THE GROWTH OF THE RECRYSTALLIZATION GRAIN AND THE HARDENING BY INTERNAL HYDROGENATION Mg–Zr ALLOYS. (PART III). Dosdat, Jean. Metaux (Corros.-Ind.), 41: 277-99(July-Aug. 1966). (In French).

The inhibition of the grain growth during heating was studied. In CO_2 atmospheres the grain growth is irregular but in H atmospheres the hydridation of the Zr is complete and the inhibition of the grain growth is more efficient. The inhibition of the growth of recrystallization crystals during heating on a previously hydridated cold work texture goes through two stages: the formation of recrystallization grains and the enlargement of the recrystallization grains. To improve the inhibition it is not necessary to increase the Zr concentration. The mechanism of the grain growth inhibition by Zr hydride is described. The structure hardened by internal hydridation was examined microscopically. The results of the study showed that the addition of Zr to nonalloyed Mg confers numerous properties that are for the most part favorable to a wider industrial utilization of the metals. (J.S.R.)

4968 CRYSTAL STRUCTURE OF THE RHOMBOHEDRICAL MODIFICATION OF THE COMPOUND YAl_3. Zalutskii, I. I.; Kripyakevich, P. I.; Ryabov, V. R.; Rubas, K. V. (Lvov State Univ.). Dopov Akad. Nauk Ukr. RSR, No. 10, 1287-90(1966). (In Ukrainian).

The alloys of Y with Al containing 71.5 to 83.3 at. % Al were studied by means of x-ray-diffraction analysis. It is shown that the rhombohedral modification of the compound YAl_3 is stable over a temperature range of 100 to 1000°C, exists in equilibrium with YAl_2 and Al, and has a structure of the $BaPb_3$ type; $a = 6.196 \pm 0.001$ Å, $c = 21.14 \pm 0.01$ Å, $c/a = 3.412$. (auth)

4969 STRUCTURE OF URANIUM–MANGANESE–ALUMINUM–IRON ALLOYS WITH CONSTANT URANIUM CONTENT OF 50 AT. PERCENT. Petzow, Guenter; Sampaio, A. Oliveira (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 57: 676-81(Sept. 1966). (In German).

Phases in the quaternary system $U\text{-}UMn_2\text{-}UAl_2\text{-}UFe_2$ were determined by thermal, metallographic, and x-ray investigations at a constant U content of 50 at.%. The surface of primary crystallization and the course of the grooves of double saturation were determined. Isothermal sections at 800, 725, 700 and 550°C as well as four temperature concentration-diagrams were worked out. A good representation of the temperature and concentration dependence of the special constitution was achieved. A method based on four-phase space geometry and multiple-proportion calculation was applied to compare experimental data in the partial diagrams and in the entire quaternary system. (auth)

4970 THE EQUILIBRIUM COTTRELL ATMOSPHERE AND THE DISCONTINUOUS YIELD IN TANTALUM–OXYGEN. Formby, C. L.; Owen, W. S. (Univ. of Liverpool). Acta Met., 14: 1841-9(Dec. 1966).

A model of the interaction of the lattice strain field associated with an interstitial atom and the stress field surrounding a dislocation is extended to enable the variation of the equilibrium atmosphere with changes in the average concentration of interstitial solute, dislocation density, and temperature to be assessed. It is assumed that the dislocations are uniformly distributed. Experimental data relating to dilute Ta–O alloys are analyzed and it is shown that, over the range of experimental conditions imposed, the extent of the discontinuous yield, measured by the locking parameter k_y, is linearly related to the concentration of the O_2 atmosphere. Using this relationship experimental data from experiments involving variation of quenching temperature, quench-ageing, strain-ageing, and annealing can be interpreted. Other data, about the change in yield drop with testing temperature, are discussed also in terms of the extent of the segregation of O_2 atoms to the dislocation. (auth)

4971 THERMOTRANSPORT OF OXYGEN IN β-ZIRCONIUM. Rieck, G. D.; Vogel, D. L. (Technological Univ., Eindhoven, Netherlands). Acta Met., 14: 1703-14(Dec. 1966).

A method is described by which the thermotransport of O_2 in β-Zr was studied. The heat of transport turns out to be 20 kcal/g-atom with a standard deviation of 2 kcal/g-atom. The periods of time which are necessary to reach a nearly-steady state distribution of the O_2 under various conditions were calculated by a method analogous to the one given by Sawatsky and Vogt. The heat of transport of N_2 in β-Zr is proved to be positive. (auth)

4972 THE CRYSTAL STRUCTURE OF $HoZn_2$. Michel, David J.; Ryba, Earle (Pennsylvania State Univ., University Park). Acta Crystallogr., 21: 818(Nov. 10, 1966). (NYO-3560-4).

The $HoZn_2$ structure, determined by x-ray diffraction, was found to be isostructural with KHg_2 and $YbZn_2$. The space group is Imma; $a = 4.456 \pm 0.001$, $b = 7.039 \pm 0.003$, and $c = 7.641 \pm 0.005$ A. Debye–Scherrer data, structure factors, and interatomic distances are tabulated. (D.L.C.)

4973 X-RAY EXAMINATION OF SOME RARE-EARTH-CONTAINING BINARY ALLOY SYSTEMS. Moriarty, J. L.; Humphreys, J. E.; Gordon, R. O.; Baenziger, N. C. (Lunex Co., Pleasant Valley, Iowa). Acta Crystallogr., 21: 840-1(Nov. 10, 1966).

Rare earth intermetallic compounds were prepared by melting in dry argon. The phases were identified using x-ray diffraction powder patterns. Lattice constants are tabulated for the following compounds: YCu, EuCu, YAg, YbAg, YbAu, YIn, LaIn, PrIn, TmIn, YbIn, TmTl, $TmPt_2$, $YbPt_2$, $TbFe_2$, $YbAu_2$, $YbAg_2$, $YbAl_3$, $TbIn_3$, $TmIn_3$, $YbIn_3$, $EuTl_3$, $TbTl_3$, $TmTl_3$, $LaPt_3$, $CePt_3$, $PrPt_3$, $NdPt_3$, $SmPt_3$, $TbPt_3$, $TmPt_3$, $YbPt_3$, La_3In, Ce_3In, Pr_3In, and Nd_3In. (D.L.C.)

4974 AN X-RAY DIFFRACTOMETRIC INVESTIGATION OF THE $\alpha \rightleftharpoons \beta$ TRANSFORMATION OF PURE URANIUM. Eisenblaetter, J.; Haase, G.; Granzer, F. (Johann Wolfgang Goethe-Univ., Frankfurt am Main). J. Nucl. Mater., 21: 53-60(1966). (In German).

The $\alpha \rightleftharpoons \beta$ transformation of pure U was investigated by x-ray diffractometry in conjunction with a high-temperature chamber. In contrast with techniques hitherto adopted (metallography, dilatometry, and electrical resistivity) this method permits direct observations of grain size and orientation in the β phase at the transformation temperature. The transformation mechanism was examined by two principal methods. (1) After each successive transformation cycle an examination was made to identify the observable diffraction lines of both phases and their intensities. (2) The counter was locked on a particular line and intensity/time plots were recorded during transformation. The results were compared with current theories of this transformation. (auth)

4975 CONTRIBUTION TO THE STUDY OF THE INHIBITION OF THE GROWTH OF THE RECRYSTALLIZATION GRAIN AND OF THE HARDENING BY INTERNAL HYDROGENATION OF Mg–Zr ALLOYS. II. Dosdat, Jean. Metaux (Corros.-Ind.), 41: 244-57(June 1966). (In French).

The hydridation of the Mg–Zr alloys was studied by determination of the solidification structure and texture, evolution of the cast texture by heating in H_2, aspect of the Zr hydride particles, identification of the hydride, and effects of the Zr concentration and the temperature of heating in H_2 on the aspect and size of the particles. Comparative treatments were made on the alloys in CO_2. The results of a chemical analysis of the alloy are tabulated. These results show that a partial hydridation is produced. It has as its origin the H_2 resulting from the reduction by Mg of the residual water vapor present in incompletely purified CO_2. (J.S.R.)

Radiation Effects

Refer also to abstract 4914.

4976 (AD–637691) ANNEALING OF GAMMA-RAY INDUCED DEFECTS IN Bi-DOPED GERMANIUM. Tseng, Ben; Ausman, George Jr. (Harry Diamond Labs., Washington, D. C.). June 1966. 15p. (TM–66–8). CFSTI $3.00 cy, $0.65 mn.

A preliminary study was made of the isochronal annealing of γ-induced defects in Bi-doped Ge in the temperature range from 318 to 523°K. Comparison of the results with previous studies on As- and Sb-doped Ge confirmed that the annealing processes in γ-irradiated n-type Ge are strongly dependent on type of donor impurity. A possible explanation is given for the differences in the annealing behavior, based on differences in the covalent sizes of the donors. (auth)

4977 (EURAEC-1696) A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Quarterly Progress Report No. 5, July 14, 1966. Trozera, T. A.; Flynn, P. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Contract AT(04-3)-617. 8p. (GA-7282). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed Under United States–Euratom Joint Research and Development Program.

Electron microscope examination of cold-worked and heat-treated A302-B steel reveals a dislocation network about $\frac{1}{35}$ of the as-received grain size. Test material has been cold worked and heat treated. The first irradiation capsule is in final stages of assembly. (auth)

4978 (NRL-Memo-1700) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS, FEBRUARY 1–APRIL 30, 1966. Steele, L. E.; Hawthorne, J. R.; Serpan, C. Z. Jr. (Naval Research Lab., Washington, D. C.). May 15, 1966. 62p.

Research is reported on the relative radiation sensitivity of A302-B steels prepared by melting and heat treating. Other work is reported on the effects of Ni content on radiation sensitivity of Ni–Cr–NaO steels, radioinduced embrittlement of high-strength steels, and the effects of neutrons on notch ductility of steels. (J.R.D.)

4979 (ORNL-TM-1583) THE EFFECT OF NEUTRON IRRADIATION ON PLASTIC DEFORMATION IN NIOBIUM SINGLE CRYSTALS. Tucker, R. P. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 162p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Unirradiated and irradiated single-pass, electron-beam-zoned Nb single crystals oriented for maximum resolved shear stress on the $(\bar{1}01)[111]$ slip system were plastically deformed in tension at 25°C. The changes upon irradiation in slip line appearance, yielding characteristics with neutron dose, and dislocation dynamics as determined by stress relaxation were investigated. The results do not clearly establish the form of the stress dependence of the dislocation velocity. (J.R.D.)

4980 COURSE OF RADIATION EFFECTS BY MICRO-HARDNESS MEASUREMENTS. Schreiner, Ilse (Univ., Vienna). Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 173: 269-98(1965). (In German).

The effects of α, β, and neutron radiation at room temperature on polycrystalline Al was investigated by means of the micro-hardness method. The method allows the course of the radiation effects to be followed in the interior of the sample. The dose independence of the hardening effect following α irradiation was investigated as a function of rolling of the samples. From measurements with isothermal and isochronal annealing treatments data were obtained about the development process. A comparison of such measurements following α, β, and neutron irradiation allowed conclusions to be made about the recovery mechanism. (L.B.S.)

4981 X-RAY STUDY OF THE RADIATION DAMAGE OF METALS. Volf, Frantisek. Pokroky Mat. Fys. Astron., 11: 134-56(1966). (In Czech).

A review of the application of x-ray methods in studies of radiation damage in metals is presented. It is noted that effects such as the change in the Bragg reflection angle, causing a shift in the diffraction line; the occurrence of diffuse reflection as well as Bragg reflection; the decrease in the intensity of Bragg reflections; the tendency toward broadening the Bragg reflections; and the occurrence of radiation scattered at small angles can be studied using x-ray methods. Each of these effects is discussed along with a statement of the mathematical basis for the changes. X-ray techniques have not been widely used, however it is predicted that there will be an increase in the application of these techniques because of improved counting methods which permit discrimination between the x-ray beam and the induced radioactivity of the sample. (TTT)

4982 LOW-TEMPERATURE γ IRRADIATION AND ANNEALING OF INDIUM ANTIMONIDE. Mashovets, T. V.; Khansevarov, R. Yu. (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 1350-5(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1690-7(June 1966).

A study was made of the influence of irradiation with ^{60}Co γ rays at 77°K on the parameters of In–Sb. Data were obtained for the dependence of the rate of formation of defects on the radiation dose and on the limiting position of the Fermi level in n- and p-type material. To explain the observed dependences a mechanism is suggested of complex (unipolar) annealing of the components of a defect during irradiation and it is suggested that the rate of this annealing depends on the charge of the defect. The isochronous annealing of defects in the 77 to 300°K range was investigated. Information was obtained on the energy scheme of defects generated by γ irradiation. (auth)

4983 INVERSION LAYERS FORMED ON n-TYPE GERMANIUM BY BOMBARDMENT WITH BORON AND ALUMINUM IONS. Pavlov, P. V.; Zorin, E. I.; Tetelbaum, D. I. (Gorkii State Univ., USSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 1425-8(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1791-5(June 1966).

The results are given of an investigation of the conductivity of inversion layers, formed on n-type Ge by bombardment with B and Al ions, using a wide range of doses, followed by annealing. The results of similar experiments, using C, Ne, and Ar ions, are given for comparison. The influence of the type of bombarding ion is demonstrated. The distribution with depth of the impurities (B and Al) introduced by the bombardment was also investigated. (auth)

4984 RESISTOMETRIC MEASUREMENTS ON MOLYBDENUM IRRADIATED WITH 2.5 MeV ELECTRONS. de Jong, M.; Afman, H. B. (Univ., Amsterdam). Acta Met., 15: 1-12(Jan. 1967).

The production and recovery of damage in molybdenum produced by irradiation with 2.5-MeV electrons at ~50°C was studied by observation of the change in electrical resistivity. All damage produced recovered completely in one stage around 195°C and is associated with an activation energy of 1.29 ± 0.04 eV. The initial recovery of the isothermal annealing is proportional with $\sqrt{t}$ whereas the tail end obeys second-order kinetics. The results are consistent with a model in which the recovery is ascribed to the random migration of interstitials to vacancies leading to their mutual annihilation, whereby the initial recovery involves predominantly the annihilation of interstitials with the vacancy from which they are originally dislodged as theoretically described by Waite. The diffusion constant for the interstitial molybdenum atom is: $D/\alpha^2 = 0.9 \times 10^{12 \pm 1} \exp\{(-1.29 \pm 0.04)/kT\}$ and the capture radius r_0 for the spontaneous annihilation of interstitials with vacancies: $15\ \text{Å} < r_0 < 36\ \text{Å}$. Independent evidence for this large capture radius is obtained from the production rate curve; saturation is observed at large doses giving a maximum concentration of Frenkel pairs of $\sim 8 \times 10^{-5}$. (auth)

4985 INTERNAL FRICTION PEAKS IN DEUTERON-IRRADIATED TUNGSTEN. DiCarlo, J. A.; Townsend, J. R. (Univ. of Pittsburgh). Acta Met., 14: 1715-22(Dec. 1966).

Polycrystalline W wires and single crystal rods were irradiated near 80°K with 13 MeV deuterons. The effects of irradiation were observed by internal friction and dynamic Young's modulus measurements taken at 78 to 300°K and 0.8 to 10 kc. During irradiation apparent pinning of dislocations reduced the friction and increased the modulus. Prolonged irradiation produced a linear decrease in the modulus. On warmup to 300°K two thermally-activated relaxation peaks, I and II, appeared in the internal friction versus temperature spectra of the polycrystalline wires (99.8% purity). Reorientation activation energies were measured as 0.17 ± 0.03 eV and 0.40 ± 0.04 eV, respectively; frequency factors were both found to be approximately 10^{13} sec^{-1}. The isothermal anneal of peak II followed first order kinetics with energy of 0.45 ± 0.12 eV and an average lifetime of 10^9 reorientation jumps. Both peak heights were observed to saturate with deuteron flux. Irradiation of high purity (99.999%) single crystals, whether unworked or heavily cold-worked, produced neither peak. It is concluded that the peaks were caused by irradiation-induced tungsten interstitials trapped at impurities. (auth)

Ceramics and Cermets

Corrosion and Erosion

Refer also to abstract 4896.

4986 MORPHOLOGICAL DEVELOPMENT OF CORROSION PATTERNS ON NATURAL, PURIFIED GRAPHITE OXIDIZED AT 620 DEG C BY DRY OR HUMID AIR. Lang, Francois-Michel; Gilles, Pierre; Magnier, Pierre; Maire, Philippe (CEN, Saclay, Gif-sur-Yvette, France). J. Chim. Phys., 63: 1084-7 (July-Aug. 1966). (In French).

It was found that corrosion patterns develop differently by oxidation in dry air and in humid air. In humid air, the morphological development of the samples was investigated as a function of higher and higher rates of reaction. (tr-auth)

4987 HIGH TEMPERATURE OXIDATION OF SILICIDES OF RARE EARTH METALS. Verkhoglyadova, T. S.; Dvorina, L. A. (Kiev Inst. of Problems in Metallurgy). Zh. Fiz. Khim., 40: 2250-4(Sept. 1966). (In Russian).

The high-temperature oxidation of the silicides of Sc, Y, La, and Ce was investigated. Sc silicides were most stable in air at high temperature and the monosilicide was the most stable up to 1000°C. The least stable was YSi_2. The dependence of the oxidation rate constants of all the silicide phases investigated on the temperature was established. The variation of the activation energy with temperature was observed for a series of compounds. Hypothetical conclusions on the mechanism of the oxidation process were made. That the oxidation process of the silicides of the rare earth metals is a complex process, taking place in several steps, is indicated by the variation of the apparent activation energy with a change in temperature. (tr-auth)

Preparation and Fabrication

Refer also to abstract 4999.

4988 (BNWL-SA-550) FIBER REINFORCED METAL MATRIX COMPOSITE STUDIES. Robinson, R. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 25, 1966. Contract AT(45-1)-1830. 39p. (CONF-661031-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Society for Metals, National Metal Exposition and Congress, Chicago, Ill.

A high energy-rate forming process used to consolidate and shape composite, refractory metal, and ceramic materials is described. Thirteen fiber reinforced-metal matrix systems are discussed. Fibers such as SiC whiskers, Al_2O_3 whiskers, B filaments, and W filaments were combined in one or more Ti, Ni, Al, stainless steel, Mo, and W metal matrices. Observations concerning the microstructure and bulk mechanical properties of composite materials formed by the high energy-rate process are briefly described. (auth)

4989 (LA-3570) FEASIBILITY STUDY FOR FABRICATION OF Cu-B_4C SHEET. Keil, R. W.; Riley, R. E.; Sheinberg, H. (Los Alamos Scientific Lab., N. Mex.). Dec. 28, 1965. Contract W-7405-eng-36. 89p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The use of Cu−B_4C control plates to replace the Al−^{10}B plates used in the Kiwi reactors was established by an extensive program involving mechanical testing, metallographic and chemical analysis, and neutron absorption and thermal expansion studies. The feasibility studies showed that Cu sheet 0.100 in. thick loaded with 21.9 wt % B_4C could be rolled and was equivalent to the former Al-20 wt % ^{10}B control plates. These studies and the process development required to produce the Cu−B_4C sheet were carried out on plates 2.0 in. by 2.0 in. of varying thickness. The process was then scaled up to the production requirements of 0.100-in.-thick sheet hot rolled from 14.75 in. by 5.75 in. by 0.42 in. hot-pressed plates. (auth)

4990 (N-66-28634) STUDY OF THE GROWTH PARAMETERS INVOLVED IN SYNTHESIZING BORON CARBIDE FILAMENTS. Final Report. Gatti, A.; Mancuso, C.; Feingold, E.; Jakas, R. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). Mar. 1, 1966. Contract NASw-1205. 53p. (NASA-CR-75673; GE-214-269). CFSTI $3.00 cy, $0.65 mn.

B_4C whiskers were grown by the vaporization at high temperature of B_4C powder and the subsequent condensation of this vapor in the form of whiskers at a lower temperature. Strength measurements were made on typical whisker specimens at both room and elevated temperatures. A room temperature tensile strength of 2×10^6 psi was measured for one such whisker. Characterization studies of B_4C whiskers by x-ray techniques, light microscopy techniques, and electron microscopy techniques were made. Composites utilizing B_4C whiskers embedded in an Al matrix were fabricated by hot pressing and liquid infiltration methods and tested in tension at room and elevated temperatures. (auth)

4991 (N-66-31363) DEVELOPMENT OF ALKALI METAL PEROXIDE AND SUPEROXIDE BLOWN CERAMIC FOAMS. Final Report, June 22, 1965–March 15, 1966. Blocker, E. W.; Paul, R. D. (United Aircraft Corp., Windsor Locks, Conn. Hamilton Standard Div.). Apr. 5, 1966. Contract NAS8-20089. 71p. (NASA-CR-76406). CFSTI $3.00 cy, $0.65 mn.

A program was conducted to develop a foam ceramic body for use as a thermal insulation. Specific areas studied included the formulation of foam ceramic bodies, using Li_2O_2 as the blowing agent, that achieve useful strength by a chemical bonding mechanism. The foam body was evaluated for physical/mechanical, thermal, and optical properties. A foam-in-place ceramic composed of zirconium phosphate-bonded zirconia was prepared and evaluated. The foam bodies exhibited good thermal and mechanical properties when tested in accord with accepted testing procedures. (auth)

4992 (WAPD-TM-579) FUEL ROD END-CLOSURE WELDING. Fischer, R. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT(11-1)-Gen-14. 53p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A program to develop reference fabrication techniques and weld designs for fuel rod end-closures is described. The welding development included resistance, W-inert-gas, and electron-beam. Evaluations of end-closures and consideration of design requirements indicate that TIG welding was found to be best for both end-closures, and the shouldered end-plug was found to be best for the lower (structural) end-closure and the recessed end-plug is best suited for the upper (or second) end-closure. The latter design has shown a high degree of freedom from weld porosity and other defects when utilized as the final seal. (J.R.D.)

4993 INFLUENCE OF ORGANIC ADDITIONS ON COLUMNAR GRAIN GROWTH OF SINTERED URANIUM DIOXIDE. Amato, I.; Ardizzone, L.; Ravizza, M. (FIAT, Turin). J. Nucl. Mater., 21: 88-95(1966).

Experiments of columnar grain growth in UO_2 pellets prepared with and without organic additions were performed. The gases originated by organic pyrolysis and contained in closed porosity have an inhibiting effect in columnar grain growth. Grain boundary migration mechanism is responsible for columnar grain growth when steep temperature gradient is applied. Poor columnar grain growth and circular voids occur in experiments with central fused UO_2. (auth)

4994 APPARATUS FOR MAKING CARBON ELECTRODES OR NEUTRONIC REACTOR CORE BARS. Juel, Leslie H.; Bailey, Bruce L. (to Great Lakes Carbon Corp.). U. S. Patent 3,267,518. Aug. 23, 1966. Filed Feb. 9, 1961.

An apparatus for the production of extrudable carbon bars or reactor core bars causes preferential orientation in the extrudable material while it is being extruded. The apparatus is comprised of two forming zones. The first forming zone is made up of a cylindrically shaped extrusion section and a transition section having a circular inlet and a substantially rectangular outlet. One dimension of the outlet is substantially less than the diameter of the circular inlet and the other dimension of the outlet is substantially greater than the diameter of the inlet. A final forming section has a substantially rectangular inlet with dimensions the same as the outlet from the transition section and has a substantially rectangular outlet whose larger dimension is substantially the same as and corresponds to the larger dimension of the inlet. The smaller dimension of the outlet is substantially the same as small dimension of the inlet. This final forming section is made up of two substantially parallel walls and two walls which converge for a portion of their length and which are adapted to compress a mass as it passes through from the transition section. (B.L.M.)

4995 CARBON ELECTRODES OR NEUTRONIC REACTOR CORE BARS. Juel, Leslie H.; Bailey, Bruce L. (to Great Lakes Carbon Corp.). U. S. Patent 3,268,385. Aug. 23, 1966. Filed Feb. 9, 1961.

A process is described for the production of an extruded green, rectangular cross sectioned carbon body that is suitable for use as electrodes or as rector core bars for nuclear reactors. The body is formed from a mixture of carbonaceous particles in platelet form and a binder, such as pitch. In their extruded condition, the platelets comprise lamellae disposed in a number of planes that are substantially mutually parallel. After the green body is baked and graphitized, it is characterized by having a coefficient of thermal expansion in the plane parallel to the planes of the crystallites that is at least twice as great as it is in each of the planes mutually perpendicular to the first plane and to each other. (B.L.M.)

Properties Evaluations

Refer also to abstract 4936.

4996 (CU-3553-5) BONDING, STABILITY, AND FORMATION OF CUBIC REFRACTORY MONOCARBIDES, MONONITRIDES, AND MONOXIDES. Denker, Stephen Paul (Columbia Univ., New York. Dept. of Electrical Engineering). Nov. 21, 1966. Contract AT(30-1)-3553. 68p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Bonding is discussed in a general way relating all the intrinsic mechanical, chemical, and electrical properties of refractory compounds as observed experimentally to the valence electron concentration. The electronic band structure is described in terms of electronic molecular orbitals (taken as a linear combination of atomic orbitals) involved in cation−cation and cation−anion interactions. The degree of anion and cation interaction can be largely described by the overlap integrals associated with clusters of atomic orbitals. Thus properties which characterize bonding and stability in these compounds can be related to the average valence electron concentration per molecule MX, and thereby directly to the atomic orbitals. It will be demonstrated how maximum stability or optimum binding energy, characterized by properties such as maximum melting point, low-vaporization rate at high temperatures, is achieved by that crystal structure in which nearly all the bonding orbitals are occupied and antibonding orbitals vacant. Since in the solid, energy states derived from both types of interactions broaden into bands and overlie each other in energy, maximum stability occurs for a valence electron concentration (VEC) between 8 and 9 valence electrons per molecule. (P.C.H.)

4997 (N-66-29370) HARDNESS OF FIVE BORIDES AT 1625 DEG C. Sanders, W. A.; Probst, H. B. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1, 1965. 8p. (NASA-TM-X-56851). CFSTI $3.00 cy, $0.65 mn.

Borides of Hf, Zr, Nb, La, and Ho were tested for hardness at a temperature of 1625°C on commercial equipment. A 2500-g load and a dwell time of 15 sec were used. In addition, hardness tests were also conducted at room temperature using a standard microhardness tester with a diamond indenter and a load of 50 g. A table of the materials tested, along with the hardness values obtained at both room temperature and at 1625°C, is given. Other information, such as the measured density, the theoretical density, grain size, and metallography of the sample is also included in the table. Plots of the data depicting the hardness of the different borides as a function of temperature are presented. (STAR)

4998 (UCRL-17083) PERMEATION OF MONATOMIC GASES THROUGH ALUMINUM OXIDE. Edwards, Richard Hugh (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 25, 1966. Contract W-7405-eng-48. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Permeation studies of He and Ar through commercial Al_2O_3 bodies were made. Permeation occurred through thin diamond ground cylindrical sections. Flow rates through the specimen were measured by a residual gas analyzer. He and Ar pressures of 380 to 1010 mm Hg at 783 to 1539°C were used for specimens containing 99.5 and 94 wt % Al_2O_3. Permeation constants and activation energies were calculated. He permeation constants up to 1.4×10^{11} and 8.1×10^9 atoms/sec cm atm and average activation energies of 13.6 ± 2.3 and 13 ± 1.7 kcal/mole were found for the 94 and 99.5% Al_2O_3 ceramics, respectively. No Ar flow through the specimens was detected at pressures up to 1010 mm Hg. The limit of detectability of the apparatus fixes k values for Ar permeation at less than 2×10^9 atoms/sec cm atm in the temperature range studied. He diffusion along continuous glassy paths was thought to be responsible for flow through both alumina bodies. (auth)

4999 HIGH-TEMPERATURE TESTS ON TUNGSTEN-CLAD UO_2-Mo SINTERED BODIES FOR THERMIONIC ELEMENTS. Schuster, K. (Battelle-Institut e. V., Frankfurt am Main). Atomwirtschaft, 11: 559-61(Nov. 1966). (In German).

Investigations were made on sintered bodies of UO_2 and Mo with W cladding in order to solve some problems in their use as thermionic elements in reactors. The heating and investigation program, external sample changes after heating, UO_2 evaporation, and microsonde surveys of the surface and of ground faces are discussed. (M.C.G.)

5000 THE METAL-RICH PARTS OF THE SYSTEMS Ta-C, Nb-C, AND V-C. Gebhardt, Erich; Fromm, Eckehard; Roy, Upendra (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Metallk., 57: 682-7(Sept. 1966). (In German).

The solubility of C in Ta, Nb, and V was investigated between 1500°C and the respective eutectic temperatures. Cylindrical specimens of pure metal were carburized at constant temperature. On the specimen surface carbide layers were formed and in the interior the metal was saturated with C. This part of the specimens was analyzed chemically to determine the saturation concentration of C in the α-solid solution. The maximum solubilities were: 6.95 at.% C at 2800°C in Ta-C, 3.65 at.% C at 2200°C in Nb-C, and 5 at.% C at 1630°C in V-C. These solubilities are higher than those obtained by conventional quenching methods but agree with those found by methods similar to those used in the present experiments. The eutectic temperature (melt + α-solid solution + β-carbide) was determined, by melting experiments. Microscopic evidence indicates a strong temperature dependence of the minimum content in the phases Ta_2C, TaC, Nb_2C, and NbC at high temperatures. (auth)

5001 ON THE INFLUENCE OF NOTCHES AND HEAT TREATMENT ON THE FATIGUE STRENGTH OF TUNGSTEN CARBIDE-COBALT ALLOYS. Dawihl, Walther; Altmeyer, Georg (Univ. des Saarlandes, Saarbruecken, Ger.). Z. Metallk., 57: 688-90(Sept. 1966). (In German).

Investigations of fatigue strength of WC-Co alloys revealed that at 6 to 15 wt.% Co the ratio of fatigue strength to static bend strength at room temperature is 0.6 independent of the grain size. The notch effect number for alloys containing 6 wt.% Co is about 1.6; the notch sensitivity is relatively small. The bending-fatigue strength is decreased by a heat treatment at 1000°C. This decrease is explained by the reduction of compressive stresses in the WC phase and is in accord with permanent changes in length which are found in these alloys after such heat treatment. (auth)

5002 METALLIC OXIDES, CARBIDES, NITRIDES, BORIDES, AND SILICIDES IN THE TECHNOLOGY OF HIGH AND VERY HIGH TEMPERATURE: PRESENT STATE AND FUTURE DEVELOPMENT. Lubatti, E.; Pappalardo, S.; Mirarchi, U. (Societa MONTECATINI, Milan). Termotecnica (Milan), 20: 540-51(Sept. 1966). (In Italian).

The basic characteristics of the refractory materials are outlined and compared with the traditional materials. The principal methods of preparation and the most important uses of metallic oxides, carbides, nitrides, borides, sulfides, and silicides are summarized. (J.S.R.)

5003 CEMENTED CARBIDES WITH HIGH-MELTING BINDERS. PART I. CARBIDES BONDED WITH Cr AND V ALLOYS. Hodson, R. L.; Parikh, N. M. (Illinois Inst. of Tech., Chicago). Int. J. Powder Met., 2: 55-63(Oct. 1966).

Carbides cemented with Cr- and V-base alloys have been investigated for potential cutting tool applications. The wettability of the carbides by liquid Cr-base alloys was measured by the sessile-drop method and a correlation of wetting angle with the microstructure of sintered samples was made. Specimens of ZrC bonded with V-Nb alloys were tested for cutting ability and, although the wear rates were high, the materials exhibited low sensitivity to cutting speed. (auth)

5004 TUGOPLAVKIE SOEDINENIYA REDKOZEMELNYKH METALLOV S NEMETALLAMI. (Refractory Compounds of Rare Earth Metals With Non-Metals). Samsonov, G. V. Moscow, Izdatelstvo Metallurgiya, 1964. 242p.

A systematic review is given of high-melting and hard systems of rare earth metals (Sc, Y, La, Ce, Pa, Nd, Lw, Eu, Ga, Tb, Dy, Ho, Er, Tm, Yb, and Lu) with boron, carbon, nitrogen, silicon, and sulfur. Physicochemical properties, crystal and electronic structure, methods of preparation, and technological applications of the rare earth borides, carbides, nitrides, silicides, and sulfides are reviewed. (106 references) (R.V.J.)

Structure and Phase Studies

Refer also to abstracts 4535, 4537, and 4540.

5005 (N-66-31769) THE PEST PHENOMENON IN INTERMETALLICS. Final Report [for] Period Ending Mar. 4, 1966. (Little (Arthur D.) Inc., Cambridge, Mass.). May 1966. Contract NASw-1167. 31p. (NASA-CR-76427). CFSTI $3.00 cy, $0.65 mn.

Intermetallic testing was conducted to induce pest in single crystals by application of a bending stress. While preliminary findings indicated that stress-free single crystals of molybdenum disilicide ($MoSi_2$) do not pest, analytical results showed that the pest phenomenon is related to the phenomenon of static fatigue or delayed failure in brittle materials. Single crystals of $MoSi_2$ exhibited delayed failure or static fatigue under pesting conditions (450 to 600°C in an oxidizing atmosphere), but pest reaction was induced in single crystals which were statically loaded in bending. Polycrystals of $MoSi_2$ measured for thermal expansion by high-temperature x-ray diffraction failed to show any large anisotropy. (STAR)

5006 ON FUSIBILITY DIAGRAM OF THE KCl-$ThCl_4$ SYSTEM. Desyatnik, V. N.; Dubinin, V. A.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Tsvetn. Met., No. 4, 87-8(1966). (In Russian).

A melt diagram for KCl-$ThCl_4$ constructed on the basis of thermograms revealed two chemical compounds; K_2ThCl_6 melting incongruently at 617°C and $KThCl_5$ melting congruently at 457°C. Two eutectic points were found for 44 to 45 mole % $ThCl_4$ melting at 376°C and for 56 to 58 mole % $ThCl_4$ melting at 416°C. In contrast to the published data thermal analysis did not confirm the existence of K_3ThCl_7 or the eutectic point at 11.7 mole % $ThCl_4$. (R.V.J.)

5007 STUDY OF EQUILIBRIUM OF 4 SOLID PHASES IN THE TERNARY SYSTEM U-C-Si. Guinet, P.; Vaugoyeau, H.; Laugier, J.; Blum, P. L. (CEN, Grenoble, France). J. Nucl. Mater., 21: 21-31(1966). (In French).

The behavior of the U_3Si phase in the ternary system U-C-Si was analyzed. Differential thermal analysis, metallography, and high-temperature x-ray methods were used on quenched samples. An equilibrium between four solid phases was evidenced as expressed by $2U_3Si + xUC \rightleftharpoons U_3Si_2C_x + (3 + x)U_\gamma$. (auth)

5008 EFFECT OF ADDITIONS OF LIME ON THE C-B TRANSFORMATION OF RARE EARTH SESQUIOXIDES. Foex, M. (CNRS, Mont-Louis, France). Bull. Soc. Franc. Mineral. Crist., 88: 521-2(July-Sept. 1965). (In French).

The addition of CaO to rare earth sesquioxides in an attempt to maintain the high temperature stable B form at room temperature was investigated. The amount of CaO necessary to ensure the disappearance of the C form is greater for higher molecular weights of the sesquioxides. For Tb_2O_3 only 0.18 wt % is necessary to cause the disappearance of the cubic phase whereas for Yb_2O_3 6.2 wt % is necessary. (J.S.R.)

5009 X-RAY STUDY OF THE SYSTEM ThO_2–CeO_2–Ce_2O_3. Whitfield, H. J.; Roman, D.; Palmer, A. R. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). J. Inorg. Nucl. Chem., 28: 2817-25(Dec. 1966).

The mixed oxide system ThO_2–CeO_2–Ce_2O_3 was investigated using x-ray powder techniques. ThO_2 forms a complete range of solid solutions with CeO_2 and the solid solutions have a fluorite structure. Reduction of mixed crystals of $(ThCe)O_2$ at temperatures in the range from 700 to 1400°C with pure, dry H_2 yields a single phase $(ThCe)O_{2-x}$, which has a fluorite structure for values of x less than 0.25. The x-ray powder photographs of $(ThCe)O_{2-x}$ in which x is greater than 0.25 showed extra lines, which may be indexed in terms of a body centered cubic structure with $a = 2a_0$ (fluorite). In vacuo density measurements on the reduced solid solutions showed them to have an anion vacancy structure. (auth)

5010 A NEW CRYSTALLINE VARIETY OF THE SESQUIOXIDES OF Tb AND Dy STABLE AT HIGH TEMPERATURE. Foex, M.; Traverse, J.-P.; Coutures, J.-P. (CNRS, Mont-Louis, France). Bull. Soc. Franc. Mineral. Crist., 88: 341 (Apr.-June 1965). (In French).

The Debye–Scherrer diagrams of Tb_2O_3 and Dy_2O_3 at 2200°C show an hexagonal structure similar to that observed in the case of the sesquioxides of La, Ce, Pr, and Nd. The crystallographic parameters are for Tb_2O_3 $a = 3.84$, $c = 6.13$, and $c/a = 1.59_7$ and for Dy_2O_5 $a = 3.82$, $c = 6.11_5$, and $c/a = 1.60_1$. (J.S.R.)

5011 REFINEMENT OF THE STRUCTURE OF $NbLi_3O_4$. Grenier, J. C.; Bassi, G. (Laboratoire d'Electrostatique et de Physique de Metal, Grenoble, France. CEN, Grenoble, France). Bull. Soc. Franc. Mineral. Crist., 88: 345-6(Apr.-June 1965). (In French).

In order to define the position parameters (particularly those of the Li atoms) a neutron diffraction study of $NbLi_3O_4$ was made. The inter-atomic distances obtained are tabulated. The present study confirms that the crystal is a body centered cube. It is probable that the octahedral environment of the O around a Nb in $NbLi_3O_4$ is constituted of two types of bonds—three short $Nb—O_{II}$ bonds and three long $Nb—O_I$ bonds. A strong covalence of Nb^{5+} is suggested by the results. (J.S.R.)

5012 THE EXISTENCE OF A NEW COMPOUND Yb_6TiO_{11} AND THE EQUILIBRIUM DIAGRAM Yb_2O_3–TiO_2. Queyroux, F. (CNRS, Vitry, France). Bull. Soc. Franc. Mineral. Crist., 88: 519-20(July-Sept. 1965). (In French).

The system TiO_2–Yb_2O_3 was studied between room temperature and 2000°C. Three phases were found. A phase of the pyrochlore with the homogeneity region extending from 1400°C with the stoichiometric composition $Yb_2Ti_2O_7$ up to 45 mole % Yb_2O_3 was studied. A solid solution of the fluorine type structure was observed with increasing concentration of the rare earth oxides. The Yb_6TiO_{11} constituted the third phase. This compound was obtained by coprecipitation with NH_3 from a mixture of $TiCl_3$ and Yb_2O_3 in HCl solution. The crystallographic parameters are given. It is stable from room temperature to 1800°C. The equilibrium diagram of TiO_2–Yb_2O_3 system is given. (J.S.R.)

Radiation Effects

Refer also to abstract 5330.

5013 (AECL-2587) POST-IRRADIATION STRUCTURES IN UO_2 QUENCHED OR SLOWLY COOLED FROM THE MELT. Bain, A. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1966. 65p. Dep. mn. AECL $1.50.

To study the effect of cooling rate on the post-irradiation structures of UO_2, 20-mm-dia by 152-mm-long elements, all with the same batch of fuel, were irradiated in three separate loadings of the X-2 pressurized water loop. During the first two irradiations, one element was slowly moved from a high to a low flux position, while another was moved from a low to a high flux position. In the first loading, a third element, ESO, was also moved but it was always in a high flux position. In the third loading, the single element was stationary in a high flux position. During movement each element passed through the peak flux position. After movement, the irradiation continued for about two weeks. The fuel center temperatures (θ_0) were >2800°C in the high and ~2000°C in the low flux positions. It was concluded that the amount of melting observed on post-irradiation examination is relevant to the power at reactor shutdown. Traces of melting, which occurred during peak power periods, were eliminated during subsequent irradiation with $\theta_0 = \sim2000$°C. The fuel diameter increases were lower than for other solid pellet fuel, but higher than for hollow fuel irradiated with the same central temperature. However, when the internal voidage of each element was considered, the diameter changes were consistent and emphasized that expansions in thin-sheathed elements can be controlled by providing voidage into which the plastic UO_2 can flow. (auth)

5014 (GA-6356) DESCRIPTION AND RESULTS OF THE TARGET P7 COATED PARTICLE IRRADIATION CAPSULE. Luby, C. S. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 22, 1966. Contract AT(04-3)-167. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Supersedes GAMD-6356, dated May 17, 1965.

Twelve types of coated fuel particles were irradiated to 16 to 24% burnup at 1000 to 1250°C. Post-irradiation examination indicated that coating failure increased with decreasing coating thickness and/or increasing particle size. A coating-thickness to particle-dia ratio of 0.4 or higher appeared to be necessary for radiation stability. Buffer-Isotropic coatings appeared equivalent in radiation stability to Triplex coatings, and coated oxides appeared equivalent to coated carbides. (auth)

5015 (GEAP-5100I) HIGH PERFORMANCE UO_2 PROGRAM. IRRADIATION OF 0.5 INCH DIAMETER, VIBRATORY COMPACTED POWDER FUEL RODS UP TO 1.5 x 10^6 Btu/h-ft^2 PEAK HEAT FLUX. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). June 1966. Contract AT (04-3)-189. 157p. (EURAEC-1736). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and the complete, correlated post-irradiation examination results are described for a four-rod fuel assembly that was irradiated. The fuel rods in this assembly were unsegmented, reactor-length rods, clad in free-standing Zircaloy-2 and fabricated by vibratory compaction to an average bulk density of 84.5%. This fuel assembly was the fourth of a series irradiated to determine the feasibility and limitations in operating compacted powder UO_2 fuel rods with central melting. (J.R.D.)

5016 (N-66-28479) DEFECT ANNEALING IN IRRADIATED SEMICONDUCTORS. Progress Report No. 4, October 1, 1965–March 31, 1966. Pritchard, W. Maurice (Old Dominion Coll., Norfolk, Va. Dept. of Physics). Apr. 1, 1966. 23p. (NASA-CR-75722). CFSTI $3.00 cy, $0.65 mn.

Empirical values of isothermal model parameters were calculated, and activation energies for vacancy motion were determined from these model parameters in connection with a study on defect annealing in irradiated semiconductors. A computer program was written to determine the best empirical fit of the annealing model to two sets of experimental isothermal annealing data for Sb-doped n-type Ge. Both theoretical and experimental curves are included. (M.W.R.)

5017 (WAPD-TM-570) BEHAVIOR OF GASEOUS FISSION PRODUCTS IN OXIDE FUEL ELEMENTS. Nichols, F. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Oct. 1966. Contract AT(11-1)-Gen-14. 39p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Theories of the mechanics of gas release from oxide fuels during fission, and the effect on fuel elements are discussed. Equations are developed to explain migration of fission-gas bubbles to the fuel center line, and to grain boundaries. Concepts are amplified to account for migration of pores by surface diffusion, and by vapor transport, under driving forces of thermal gradients, strain energy gradients, stressed locations, and moving grain boundaries. Diagrams are presented to indicate expected extent of columnar grain growth for UO_2, ThO_2, and ZrO_2, as a function of center line temperature in a cylindrical fuel element. (P.G.C.)

5018 DIRECT OBSERVATION OF FISSION FRAGMENT DAMAGE IN SOME CERAMIC OXIDES. Chute, J. H. (Atomic Energy Commission, Lucas Heights, Australia). J. Nucl. Mater., 21: 77-87(1966).

Fission fragment damage in thin flakes and films of BeO, ThO_2, and Al_2O_3 was studied by transmission electron microscopy. No fission tracks were found in Al_2O_3 and only occasional tracks were detected in BeO; however, well-defined tracks were present in ThO_2. The nature of the tracks is consistent with an ionization process as the main mechanism of energy loss. Although nuclear collisions do occur, such events are comparatively rare. (auth)

5019 DIFFUSION MEASUREMENT IN NON-GAS FORMING SPALLATION PRODUCTS IN URANIUM DIOXIDE. Naumann, D.;

Pietzsch, H.; Riedel, S. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 241-2(July 1966). (In German).

The diffusion of UO_2 spallation products were studied using fused salt elution. The diffusion coefficients for Cs, Ba, and Sr at 750 and 800°C were obtained under reactor radiation for UO_2 powder. (tr-auth)

Plastics and Other Materials

Refer also to abstract 4896.

5020 (SC-DC-66-2326) ADHESION OF ENCAPSULANTS. Quant, A. J. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1966. Contract AT(29-1)-789. 44p. (CONF-661109-1). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From EIVR-10 Meeting, Livermore, Calif.

The joint strength of bonds between various combinations of encapsulating resins and substrates as a function of humid and dry, room temperature aging was determined. The encapsulants chosen included all those types that are commonly used. The substrates chosen were representative of materials found in encapsulated packages and of materials in encapsulated cable terminations. Data were obtained on the expected aging and on unmeasured bond strengths as a function of temperature. A study of the accumulated data revealed that no serious problem exists concerning aging effects, wet or dry, on the adhesion of these encapsulants to the various substrates. (auth)

5021 (SCL-CR-66-91) MATERIAL DEVELOPMENT. Final Report, March 15, 1963–March 1, 1965. O'Neal, John R. (Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.). Nov. 1966. Contract AT(29-1)-789. 94p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Sandia Corp., Livermore, Calif.

Properties of polybenzimidazole-boron moldings were evaluated. The material was studied for thermal reactions, optimization of advancement, molding properties, and mechanical and physical tests were made on molded specimens. No reaction occurred between polybenzimidazole and boron when heated up to 1000°F. The volatile content of polybenzimidazole had to be reduced to approximately 1% before dense moldings could be made. Polybenzimidazole–boron moldings had approximately twice the mechanical strength of commercially available phenolic molding compounds. All the residual stresses could not be relieved in the moldings, but removing them from the mold at 700°F and cooling in a 600°F oven resulted in significant improvement. Annealing moldings at 800°F was not sufficient to reduce their stresses. Since this material has a heat deflection temperature of 920°F, 1000°F may be required to relieve stresses. Compressive specimens of composites deformed at 800°F; therefore, it may be possible to postform molded sheet to any desired shape. Dense moldings, greater than 0.25 in. in thickness, were difficult to make. If thicknesses greater than 0.25 in. are required, laminated molded layers may be the solution. It was concluded that moldings should be annealed by raising the temperature from room temperature to 1000°F. Annealing to 1000°F eliminated almost all the stress in a 12-in. × 12-in. × $^5/_{16}$-in. molding and then flexural specimens were easily cut without stress cracking of the molding. The molding was placed in a steel bag inside an oven. The bag was purged with argon at 3 l/minute and the oven temperature raised from room temperature to 300°F at 3°F/minute. This temperature was held 20 minutes, then increased 50°F at 3°F/minute. The temperature was increased in 50°F steps with 20 minutes at each temperature until 1000°F was reached. At 1000°F the oven was turned off and allowed to cool with the door closed. Then at 300°F the argon was stopped and the molding removed. (auth)

5022 CRYSTALLOGRAPHIC STUDY OF NEW RARE EARTH AND COPPER SULFIDES. I. Ballestracci, R.; Bertaut, E. F. (CEN, Grenoble, France. Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). Bull. Soc. Franc. Mineral. Crist., 88: 575-9(Oct.-Dec. 1965). (In French).

The existence of at least five phases in the system $T_2S_3-Cu_2S$ (T = rare earth) was found. The hexagonal phase $T_xCu_yS_2$(3X + y = 4) or $T_2S_3 \cdot nCu_2S$ where for T = Er for example n varies between $^3/_2$ and 3 is described in detail. This phase crystallizes in the $P_3-(C^1_{3i})$ group. T is in (0 0 0) and S and Cu are in positions 2d ± ($^1/_3$ $^2/_3$ z) (with z_s = 0.75 and z_{Cu} = 0.375). T is hexacoordinated and Cu is tetracoordinated. The packaging of the anions is hexagonal compact. (tr-auth)

5023 NEUTRON ABSORBING MATERIALS FOR NUCLEAR REACTORS. Petzow, Guenter; Preisler, Eberhard; Haessner, Frank (to Max-Planck-Institut fuer Metallforschung). German Patent 1,222,596. Aug. 11, 1966. Filed Aug. 23, 1962.

The neutron absorbing material is a mixture of high melting compounds which contain In or Cd as well as Hf, Ta, Mo, Co, Mn, Sb, As, or W. The compounds are oxides of the type $MI_xMII_yO_z$, wherein MI is the fraction of In or Cd and MII is the fraction of the other named metals. O is the fraction of oxygen. (Gmelin)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 4794, 5072, 5102, 5163, 5191, 5192, 5270, and 5375.

5024 (N-66-31745) INVESTIGATIONS OF THE INTERACTION OF SOLAR FLARE PARTICLE WITH THE CORONAL PLASMA. Final Report. Oster, Ludwig (Yale Univ., New Haven, Conn. Observatory). [1966]. 8p. (NASA-CR-76457). CFSTI $3.00 cy, $0.65 mn.

A brief summary of the publications which originated from this research is presented. One study showed that a resonance at the electron plasma frequency is present which is of the general form required to explain the type-III radio bursts from the sun. Quantitative applications showed that the observed intensities and half-widths of type-III bursts can be understood by postulating the passage of quite reasonable numbers of fast particles. Brief additional comments are made concerning each of the 20 references which appear in the bibliography. (STAR)

5025 (N-66-32640) VARIATIONS IN THE INTERPLANETARY MAGNETIC FIELD: MARINER 2. PART III. SOME EFFECTS UPON SOLAR COSMIC RAYS. Coleman, Paul J. Jr. (California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics). May 12, 1966. 53p. (NASA-CR-76944). CFSTI $3.00 cy, $0.65 mn.

The observed properties of the variations in the interplanetary field, are employed in developing a model for the typical interplanetary field. Some properties of the behavior of solar protons in the model field are determined. It is shown that: protons with energies less than 1 MeV would travel adiabatically throughout the solar system; protons with energies in the range 1 to 100 MeV would first encounter efficient scattering at heliocentric ranges beyond 1 au; protons with energies in the range 100 MeV to 1 BeV would encounter efficient scattering at ranges near 1 au; and, protons with energies greater than 1 BeV would first encounter efficient scattering at ranges less than 1 au. It is argued that various properties of solar-proton events may be accounted for by this model. However, nonrelativistic solar-flare electrons would travel adiabatically throughout interplanetary space. It is shown that a good deal of the observed spread in the directions of travel of solar protons in the interplanetary field at the onset of an event is probably due to the variations in the orientation of the field rather than to a spread in particle pitch angles. (auth)

5026 (N-66-32668) VARIATIONS IN THE INTERPLANETARY MAGNETIC FIELD: MARINER 2. PART II. INTERPRETATION IN TERMS OF HYDROMAGNETIC WAVES. Coleman, Paul J. Jr. (California Univ., Los Angeles. Inst. of Geophysics and Planetary Physics). May 5, 1966. 46p. (NASA-CR-76943). CFSTI $3.00 cy, $0.65 mn.

Some characteristics of the variations of the interplanetary magnetic field and the plasma velocity, observed during the flight of Mariner 2, are considered. First, properties of the power spectra from records of the plasma velocity and the three vector components of the field are described. Next, the properties of the cross spectra between pairs of this set of four variables are described. The variations that would be produced in the plasma velocity and the field components by hydromagnetic waves are determined from a model of a uniform, perfectly conducting, isentropic, ideal gas in a uniform magnetic field. The properties of the variations determined empirically are compared with those determined from this model. (auth)

5027 (NP-16400) NEUTRINOS IN SUPERDENSE MATTER. IV. MASSIVE NEUTRINOS IN A PERFECT FLUID SPHERE. Kuchowicz, Bronislaw (Warsaw Univ. (Poland). Dept. of Radiochemistry). Apr. 1966. 11p. Dep.

The study of neutrino motion in superdense matter bulks is extended to neutrinos of a non-zero rest mass. The results do not introduce any essential change into the picture of neutrino motion which has been obtained previously. (auth)

5028 VARIATIONS IN THE INTERPLANETARY MAGNETIC FIELD: MARINER 2. I. OBSERVED PROPERTIES. Coleman, Paul J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res., 71: 5509-31(Dec. 1, 1966).

Properties of the variations in the interplanetary magnetic field observed between August 27 and November 15, 1962, are described A heliocentric spherical polar coordinate system is employed. The polar axis is the sun's axis of rotation. The field is described in terms of the vector components, B_r, B_θ, and B_φ in this system. It is shown that the amplitude distributions of the magnitudes of the vector components of the field, taken over periods of a single field polarity, are roughly Gaussian. The widths of the distributions yield variances of 5.8, 10.0, and 10.0 γ^2 for B_r, B_θ, and B_φ, respectively. The variance in the direction radial from the sun is significantly smaller than the variances in either of the two transverse directions. Estimates of the power spectra for each of the three vector components are given over the frequency range 1.16 to 1160 cycles per day (cpd). Comparison of the spectra shows that variations in the radial direction are weaker than those in the θ and φ directions over the entire frequency range. The various ratios of the power densities of B_r, B_θ, and B_φ are shown to be roughly independent of frequency. The power densities in the spectra are steeply decreasing functions of the frequency with a dependence between f^{-1} and f^{-2} between 100 and 500 cycles per day. Beyond 500 cpd the power densities are usually below 9.1 γ^2/cps, the system noise level. Estimates of the cross spectra of the various pairs of field variables are given over the same frequency range, 1.16 to 1160 cpd. Significant coherences are established, and the phase relationships are described. Estimates of the cross spectra of B_r, B_θ, and B_φ with the plasma velocity are given over the frequency range 1.16 to 116 cpd. Significant coherences are established for these pairs of variables as well, and the phase relationships are described also. (auth)

5029 ON THE MOST ECONOMICAL WAY TO MEASURE AUTOCORRELATIONS IN A RADIATION FIELD. Kahn, F. D. (Univ. of Manchester, Eng.). Brit. J. Appl. Phys., 17: 1339-46 (Oct. 1966).

The spectrum of a radiation field can be determined from a knowledge of the autocorrelation function $\Gamma(\tau)$ of its electric field. $\Gamma(\tau)$ can, in turn, be found from measurements of the "clipped" correlation function $G(\tau)$, which simply refers to the sign of the electric field. Given a certain length of time for an experiment, the signal-to-noise ratio in determinations of $G(\tau)$ can to some extent be improved by spacing observations more closely together. But if successive pairs of observations are too close together then little further information is derived. An analysis is given which helps to estimate the spacing for optimum efficiency. (auth)

5030 X-RAY AND GAMMA-RAY ASTRONOMY. Weekes, Trevor C. (University Coll., Dublin). Sci. Progr. (London), 54: 543-60(Winter 1966).

The recent observations of a large flux of X-rays from rocket and satellite experiments has opened up a new branch of astronomy. Although the subject is still in the early stages, many interesting results have been obtained. The detection of a number of X-ray point sources, whose origin is not yet clear, introduces the idea of a new class of astronomical object, the X-ray star or galaxy. (auth)

5031 CONCERNING ONE POSSIBLE TYPE OF STABLE PARTICLES IN THE GALAXY. Stanyukovich, K. P. (Scientific-Research Inst. of Introscopy, USSR). Dokl. Akad. Nauk SSSR, 168: 781-4(June 1, 1966). (In Russian).

The possible existence of quasiparticles (called planckeons) of dimensions equal to the gravitational radius and to their internal radius of curvature, with an internal field corresponding to a Schwarzschild field is considered. It is shown that such particles constitute stable closed Einstein microworlds and are stable against both electromagnetic and gravitational radiation. Their total mass is estimated at approximately the mass of the metagalaxy, so that their energy is of the same order as that of other forms of energy, as should be the case for the uniform model of the universe. Calculation of the frequency of collision of such particles with nucleons shows that the energy released by these collisions is sufficient for formation of new nucleons in accordance with the Dirac–Hoyle theory. The relation between these new particles and heavy gravitons, "maximons," quarks, particles produced by galactic explosions, and similar fundamental particles, is indicated. Arguments are presented in favor of the hypothesis that quasars and other metagalactic objects are made up of such superdense particles produced in the past and still being produced during the evolution of the metagalaxy. The relation between this hypothesis and other cosmological theories is discussed. The possible existence of other "closed" particles in the metagalaxy is proposed and some of their properties are tabulated. A scheme for the interrelation between elementary and fundamental particles is indicated. (ATD)

5032 DETERMINATION OF PREATMOSPHERIC METEORITIC DIMENSIONS. Lavrukhina, A. K. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 168: 1275-8(June 21, 1966). (In Russian).

The only way to determine the size of meteors before they enter the terrestrial atmosphere is to study the formation speed of cosmogenic isotopes generated by the interaction of cosmic rays with the meteoric matter. This method is based on the difference in excitation functions of various nuclear-reaction product groups. Nuclear-reaction products are classified into two groups with $\Delta A < 10$ and $\Delta A > 10$, where ΔA is the difference of products gained by protons of different energies. The speed of isotope $H_{\Delta i}$ formation in the i-point in the meteor body is a function of the intensities of primary cosmic radiation and active secondary nuclear particles. The particle spectrum and the energy function determine the role of each kind of particle in the A_i isotope formation. Isotope formation in meteors of various radii is distributed differently, depending upon the length of the radius and the production class group. The quantity of secondary mesons and protons was determined from their spectra as obtained in the atmosphere. Nomograms were drawn for isotopes from the data of a series of meteoric bodies. The accuracy of the method is based on radiometric determination of low cosmic-ray activity and their stability in the solar system. (ATD)

5033 FRAGMENTATION OF A CLOUD AND THE MASS FUNCTION OF STARS IN GALACTIC CLUSTERS. Nakano, Takenori (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 515-29(Sept. 1966).

The process of star formation in a contracting interstellar cloud is investigated. The growth of density fluctuations is discussed and the cloud is considered to disintegrate into many fragments during its contraction. The interstellar cloud has a finite angular momentum. Therefore the free-fall contraction of the cloud is stopped by the centrifugal force at a certain stage. Afterward, the fragments move randomly in the cloud. The collision time of the fragments with one another is nearly equal to or shorter than their contraction time, and the evolution of fragments cannot be studied without considering their mutual collisions. The kinetic energy of fragments, which is dissipated into the thermal energy by collisions, is much smaller than the dissociation energy of H_2 molecules for a cloud of about $10^4 M_\odot$. Then the temperature of the fragments, which has risen to about 1000°K as a result of the collision, falls rapidly by the cooling processes due to H_2 molecules and grains, and the fragments do not disperse after the collision. This suggests that some of the collisions lead to the coalescence of the fragments which take part in them. The coalescence process of the fragments is investigated by means of a simplified model in order to derive the mass function of the stars in a star cluster. The results are compared with the mass functions of stars in galactic clusters. (auth)

5034 CENTRAL TEMPERATURE AND DENSITY OF STARS IN GRAVITATIONAL EQUILIBRIUM. Takarada, Katsuo; Sato, Humitaka; Hayashi, Chushiro (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 36: 504-14(Sept. 1966).

The relation between the central temperature and the central density is investigated for a polytropic star and a polytropic (or isothermal) stellar core, which are in gravitational equilibrium. The ranges of the temperature and density cover the cases of nondegenerate and degenerate, nonrelativistic as well as relativistic, electrons. It is shown that, when the mass of the star or of the core is smaller than a certain critical value which depends slightly on the polytropic index N and is equal to Chandrasekhar's limiting mass for $N = 3$, the central temperature takes a maximum value depending on the mass at the onset stage of the electron degeneracy. (auth)

5035 SOLAR PLASMA FLOWS OBSERVED ON MARINER 2 AS FREE ROTATING STREAMS. Ivanov, K. G. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 149-53(1966).

Translated from Geomagn. Aeronomiya, 6: 190-6(1966).

Observations on Mariner 2 and the assumption that corpuscular streams are free jet streams are used to estimate the properties of such streams in interplanetary space from September 2 to October 16, 1962. The width of the streams is 0.3 to 1 au. Widening, additional to self-similar widening, varies from 1.5 to several times. The two halves of the stream are asymmetric. The asymmetry coefficient varies from 1.7 to 2.3. The magnetic fluxes are equal to the two halves of the streams. The magnetic field in the sources is of the order of 1 to 10 Oe. The maximum field value and the coefficient of asymmetry of the stream are higher for an SSC storm than for a storm with a gradual commencement. With the exception of the most intense stream, active periods on earth occurred only during passage through the first half of a stream. Arguments are presented in favor of the fact that at distances of 5 to 10 radii from the sun the streams can be investigated on the basis of equations of magnetohydrodynamics with ideal electric conductivity, subsequently using a system of equations with a self-consistent field or a quasihydrodynamic approximation, and that a turbulent boundary layer forms on the streams in the corona. (auth)

5036 PROPAGATION OF HIGHLY ENERGETIC SOLAR PROTONS IN THE INTERPLANETARY MAGNETIC FIELD. Shishov, V. I. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 174-80(1966).

Translated from Geomagn. Aeronomiya, 6: 223-30(1966).

The kinetic equation in the Fokker–Planck approximation is used to describe the propagation of highly energetic protons in the interplanetary medium. The solutions of this equation are analyzed to clarify the conditions under which strong anisotropy is observed in the angular distribution of relativistic protons generated during solar flares. A comparison of theoretical results with observational data on the flare of May 4, 1960, shows that the diffusion coefficient, D, increases with distance from the sun approximately as r^2. In the vicinity of the earth's orbit $D = 5 \times 10^{22}$ cm²/sec. (auth)

5037 FACTORS CONTROLLING JOVIAN DECAMETRIC EMISSION. Duncan, R. A. (CSIRO, Camden, Australia). Planet. Space Sci., 14: 1291-1301(Dec. 1966).

Only those Jovian decametric storms whose maximum radiofrequency reaches or exceeds 30 Mc exhibit the strong well-known pattern of peak occurrence at Io phases 90 and 230°. The majority of storms, those which fail to reach 30 Mc, exhibit a weaker and more complex pattern. The maximum radio-frequency of storms also determines the pattern of occurrence with Jovian longitude, though the structure of this pattern is tens of Mc wide. On a fine scale, it is not the radio-frequency, nor primarily the central time, but the commencement time of storms which correlates with Jovian longitude. Most main-source storms are first seen on Earth as Jupiter's Northern Hemisphere magnetic pole ($\lambda_{III} = 200°$) crosses the central meridian. The current belief that Jupiter's radio rotation period has lengthened during the last few years is probably erroneous. (auth)

5038 THE BRIGHTNESS TEMPERATURE AND POLARIZATION OF VENUS AT 3.75-cm WAVELENGTH. Kuzmin, A. D.; Dent, W. A. (Lebedev Inst. of Physics, Moscow. Univ. of Michigan, Ann Arbor). Soviet Astron.-AJ (Engl. Transl.), 10: 544-5 (Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 692-4(May-June 1966).

Results are presented of measurements of the brightness temperature and polarization of the integrated radio emission of Venus at 3.75-cm wavelength, as obtained in August and September 1964 with the 26-m radio telescope of the University of Michigan. The instrumentation is described briefly. Near the angle $\Phi = 85°$ the brightness temperature of Venus was measured as 659 ± 65°K. A 1% upper limit was found for the polarization of the integrated radio emission. Measurements were also made of the polarization of the radio emission from the discrete sources 3C 123 and 3C 273; the degrees of polarization are 4.0 and 1.8%, and the position angles, 160 and 150°. (auth)

5039 INVESTIGATION OF THE ELLIPTICAL POLARIZATION OF THE OPTICAL RADIATION OF THE CRAB NEBULA. Dzhakusheva, K. G.; Mychelkin, E. G. (Astrophysical Inst., Academy of Sciences, Kazakh SSR). Soviet Astron.-AJ (Engl. Transl.), 10: 429-33(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 543-9(May-June 1966).

Results of measurements of elliptical polarization of the 5300- to 6300-Å radiation of the Crab Nebula (M 1), made with the 50-cm meniscus telescope of the Astrophysical Institute of the Academy of Sciences of the KazSSR, from October to December 1964, are given. Elliptical polarization of predominantly left rotation is detected and a diagram of the elliptical polarization of the radiation for 54 points in M 1 is given. The degree of ellipticity ϵ, defined as the amplitude ratio of the principal axes of the polarization ellipse, is, on the average, of the order of 0.2 to 0.3. The degree of elliptical polarization P exceeds the degree of polarization P_1, obtained on the assumption that the radiation is partially linearly polarized, on the average (5 ± 3)%. (auth)

5040 PROPAGATION OF SHOCK WAVES IN A GAS–DUST MEDIUM. II. Gidalevich, E. Ya. (Astrophysical Inst., Academy of Sciences, Alma-Ata, Kazakh SSR). Soviet Astron.-AJ (Engl. Transl.), 10: 437-9(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 553-6(May-June 1966).

The dynamics of dust in a stationary shockwave is studied for the cases $P = \text{const}$ and $P = \rho c^2$. The gas and dust velocities are evaluated at an infinite distance from the shock front. The motion of growing and decaying particles in shock waves is considered qualitatively; the final dust velocity is the same in these two situations. In the stationary problem the ultimate dust-particle concentration is $N_{g_\infty} = N_{g_0} (N_{H_\infty}/N_{H_0})$. (auth)

5041 CLASS OF QUASI-INTEGRALS IN STELLAR DYNAMICS. Marochnik, L. S. (Inst. of Astrophysics, Academy of

Sciences, Dushanbe, Tadzhik SSR). Soviet Astron.-AJ (Engl. Transl.), 10: 442-7(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 560-6(May-June 1966).

The solutions of the approximate drift equations of motion for rotating stellar systems are found to be quasi-integrals. (auth)

5042 MAGNETIC FIELDS AT VARIOUS DEPTHS IN THE SOLAR ATMOSPHERE. Severnyi, A. B. (Crimean Astrophysical Observatory, Academy of Sciences, USSR). Soviet Astron.-AJ (Engl. Transl.), 10: 367-79(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 465-79(May-June 1966).

Previous magnetographic measurements of the chromospheric field in Hβ and the K line of Ca^+ are untenable: Hβ is so strongly blended with metal lines that the photospheric rather than chromospheric field is probably recorded, while the K-line records probably represent variations in the profile slope rather than the magnetic field. Hα is best for measuring chromospheric fields. The double magnetograph of the Crimean Astrophysical Observatory simultaneously records magnetic fields in any two lines, the central and wing intensity, and the radial velocities. It has furnished much information on longitudinal fields, velocities, and monochromatic intensities at different levels in the solar atmosphere (the Hα, λ 6102.7 Ca, and λ 5250 Fe lines were used). In ≈70% of the cases, all the features of the photospheric field (λ 5250) are repeated at the chromospheric level (Hα), although the chromospheric fields have less fine structure, are more extended, and are sometimes displaced across the disk from the corresponding photospheric fields. In ≈30% of the cases anomalous fields appear in the chromosphere with opposite sign or greater strength than recorded for the photosphere. Usually the effect arises trivially from a particular field alignment relative to the line of sight at a given level, but small tubes of force may loop into the photosphere, carrying a field oppositely directed from the chromospheric field and resulting in contact between opposing fields. An accurate position for the October 4, 1965, flare, determined from Hα isophotes, agrees well with the site where such fields appeared. Some highly interesting isolated fields with a single sign have been observed only at an intermediate level (λ 6102.7) between the photosphere and chromosphere (λ 5250 and Hα). It is very hard to understand how such fields can occur, since no oppositely signed field permitting closure can be found either in the vicinity or at different depth. Zigzags appear in the π component for some spots, indicating an oppositely signed field in the spot interior. The facts mentioned all confirm the very fine structure of solar magnetic fields. (auth)

5043 PHOTOSPHERIC STRUCTURE ABOVE A SUNSPOT. Korobova, Z. B. (Tashkent Astronomical Observatory). Soviet Astron.-AJ (Engl. Transl.), 10: 380-7(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 480-7(May-June 1966).

Through photometric reduction, three types of photospheric bridges in sunspots are distinguished by structure, height of occurrence, and temperature regime: (I) bridges associated with spot decay (lower level); (II) bridges representing facula chains superposed on spots (intermediate level); (III) arch-bridges apparently involving prominences near spots (upper level). The effective temperature of type-I bridges is determined. The degree of transparency of faculae is estimated. (auth)

5044 AN ANALYSIS OF THE CHEMICAL COMPOSITION OF NOVA ENVELOPES. III. QUANTITATIVE ANALYSIS OF THE ATMOSPHERE OF NOVA HERCULIS 1934 DURING DECLINE. Mustel, E. R.; Baranova, L. I. (Astronomical Council, Academy of Sciences, USSR). Soviet Astron.-AJ (Engl. Transl.), 10: 388-95(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 488-98(May-June 1966).

The spectrum of the envelope of Nova Herculis 1934 during decline on December 28, one week after maximum light, is compared with the spectrum at maximum and the spectrum of ε Aur. The chemical composition of the nova is analyzed by curves of growth. The relation between excitation temperature T_e and excitation potential shows that T_e was higher on December 28 than at maximum light. The ionization temperature and electron concentration are estimated for the envelope, including the dilution factor. The composition determined for the envelope is compared with the standard composition; the previous suggestion of anomalous carbon content is supported. (auth)

5045 INITIAL STELLAR MAIN SEQUENCE. Ruben, G. W.; Masevich, A. G. (Potsdam Astrophysical Observatory, Germany). Soviet Astron.-AJ (Engl. Transl.), 10: 396-406(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 499-512(May-June 1966).

Sequences computed for 77 homogeneous model stars with $2\odot \leq M \leq 16\odot$, $0.50\odot \leq X \leq 0.99$, $0.001 \leq Z \leq 0.05$, and two different absorption coefficients, are compared with similar theoretical sequences obtained by other authors and empirical initial sequences. Theoretical and observed relations between mass and luminosity, radius, and mean density are considered. Possible sources of discrepancy are discussed, in particular for low-mass stars, whose computed radius and luminosity are systematically smaller than observed. For $2.5\odot \leq M \leq 30\odot$, existing homogeneous models (initial main sequence) agree satisfactorily with observation, allowing for dispersion in the physical parameters adopted by different authors and for possible observational error. (auth)

5046 INTERPLANETARY SCINTILLATION OF 3C273. Sinigaglia, Gianfranco (Univ., Bologna). Nature, 212: 601 (Nov. 5, 1966).

In the period between Sept. 15 and Oct. 14, 1965, 3C 273, observed with the east–west arm of the "Northern Cross" at 408 Mc, showed interplanetary scintillation. The distance of the line of sight from the Sun ranged from 0.3 to 0.08 au. A continuous increase in scintillation as the distance decreased was observed. The diameter of the core of the B component of the source 3C 273 should be equal to or less than 0.1 sec of arc. (W.D.M.)

5047 SUPERNOVA REMNANT W-44: OBSERVATIONS AT 8350 MEGACYCLES PER SECOND. Hollinger, J. P.; Hobbs, R. W. (Naval Research Lab., Washington, D. C.). Science, 153: 1633-4(Sept. 30, 1966).

The region of W-44 was mapped at 8350 megacycles per second. The degree of linear polarization of the most intense portion of W-44 integrated over the 10.8-minute-of-arc beam was 11 ± 2% at position angle 45° ± 5°. This high degree of polarization is further evidence that W-44 is a supernova remnant. The integrated flux density of $(95 \pm 25) \times 10^{-26}$ W/m^2cps for this source is consistent with measurements at lower frequencies extrapolated with the use of a spectral index of −0.44, obtained by other observers. In addition, the compact source 3 minutes of right ascension west of W-44 was unpolarized, within the error of measurement. The flux density of $(23 \pm 6) \times 10^{-26}$ W/m^2cps determined for it along with the results of other observers indicate that this source has a thermal spectrum. (auth)

5048 STATISTICAL PROPERTIES OF RADIOGALAXIES. Lequeux, J. (Observatoire de Paris, Meudon, France). Ann. Astrophys., 29: 533-4(Sept.-Oct. 1966). (In French).

The distance was calculated for the radiogalaxies in the revised 3C catalog whose spectral shift is known. The luminosity distribution and the linear extension of the galaxies in the revised 3C were plotted and compared with previous attempts to study the radiogalaxies statistically. The relation between the monochromatic luminosity P_{178} and the linear extension of the radiogalaxies of the revised 3C is also discussed. (G.O.Y.)

5049 SOME OBSERVATIONS OF WEAK RADIO SOURCES WITH THE CAMBRIDGE ONE-MILE TELESCOPE. Kenderdine, S.; Ryle, Martin; Pooley, G. G. (Cavendish Lab., Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 134: 189-210(1966).

Observations of very weak radio sources made with the one-mile radio telescope in an area of sky centered on $\alpha = 09^h40^m$, $\delta = 50°$ are described. The main observations, on 408 Mc, covered an area approximately 4° in diameter, and allowed the detection of sources having a flux density $S_{408} \geq 25 \times 10^{-29}$ $w.m^{-2}(c/s)^{-1}$, a value about $^1/_{40}$ of that of the weakest sources in the 4C survey; the positions of these sources could be established with an accuracy of about 5″ arc in each coordinate. A few sources were also observed on 1407 Mc, with an accuracy of 1.5″ arc. A number of the sources could be resolved and contour maps of some of the extended and multiple sources are presented. A search for optical objects in the positions of all the sources was made using the prints of the 48″ Sky Survey, and several probable identifications were made. (auth)

5050 C-FIELD COSMOLOGICAL MODELS. McIntosh, C. B. G. (Univ. of New England, Armidale, Australia). Mon. Notic. Roy. Astron. Soc., 134: 211-20(1966).

A vector field $C_\mu = F(t)\ (1,0,0,0)$ defined at each point of space-time when the curvature is zero, and when $R(t)$ has the form At^n, leads to a series of cosmological models, each with constant deceleration parameter q_0. These "C-field" models satisfy Hoyle's relativistic equations. Hoyle's steady-state model is the special case where $F(t)$ = constant (though $R(t)$ is now exp (Bt)). The C-field model with $q_0 = +1$ and the relativistic oscillating model when $q_0 = +1$ have the same [m,z] relation. For other C-field models, the [m,z] curves lie in slightly different regions of the [m,z] plane than those of the relativistic models with corresponding values of q_0. Use of the Lie derivative shows that a field $C_\mu = F(x^\mu)\ (1,0,0,0)$ defined at each point in space-time does not give models satisfying the cosmological principle except where $F(x^\mu) = F(t)$. (auth)

5051 POSSIBILITY OF FRAGMENTATION OF A PRE-GALAXY WITH LARGE INTERNAL VELOCITY DIFFERENCES.

Grzedzielski, S. (Univ., Warsaw). Mon. Notic. Roy. Astron. Soc., 134: 109-34(1966).

The possibility of partial fragmentation of a pre-galaxy in an early phase of contraction is investigated. The proposed mechanism consists in the formation of unstable configurations of high density (with a short collapse time scale), due to the cumulative effect of random shock waves, generated by large velocity differences supposed to exist initially. The discussion of the cooling of the gas and of the geometrical effects of cumulative compression enables us to formulate the necessary conditions for the occurrence of fragmentation. The kinetic energy of the gas motions is of the order of the gravitational energy, initial masses of typical velocity cells are of the order of 10^9 solar masses, and the radius R of the pre-galaxy is less than 100 kpc. The resulting unstable masses are of the order of 10^8 solar masses, and their collapse time scale is reduced by factor $\simeq 10$. If an enrichment in heavy elements takes place, a second stage of fragmentation may occur, leading to masses of the order of 10^5 to 10^6 solar masses. (auth)

5052 NARROW-BAND PHOTOMETRY IN THE STUDY OF STELLAR POPULATIONS. I. THE SODIUM D LINES IN LATE-TYPE STARS. Price, M. J. (The Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 134: 135-70(1966).

Narrow band photoelectric measurements of the strength of the sodium D lines in the spectra of 400 G, K field stars of all luminosity classes were made, and the data discussed in terms of spectral classification, in conjunction with known parameters of spectral type, luminosity class, color and Mg b line measurements. The D lines are an excellent indication of luminosity class, in the sense that discrimination between dwarfs and other luminosity classes is unambiguous, and they are very sensitive to temperature, increasing monotonically with advancing spectral type. A "population effect" was found in the sense that high-velocity stars had weaker D lines, and stronger magnesium b lines than low-velocity stars of the same (B−V) color. Using curve of growth theory to examine the behavior of the D and b lines with temperature, surface gravity and chemical composition, the population effect was interpreted as indicating a deficiency of sodium in high-velocity stars, while there is evidence that the magnesium abundance in high-velocity stars is not so dissimilar from that in low-velocity stars. The possibility of calibrating D-line strengths directly in terms of total metal abundance, in dwarf stars, was examined with some success. (auth)

5053 NARROW-BAND PHOTOMETRY IN THE STUDY OF STELLAR POPULATIONS. II. COMPARISON OF THE HYADES AND COMA BERENICES OPEN CLUSTERS. Price, M. J. (The Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc., 134: 171-81(1966).

The strengths of the Hα and Mg b lines were measured in the spectra of 53 Hyades cluster members and 31 Coma Berenices cluster members in an examination of the use of narrow-band photometry in determining metallic composition differences between dwarfs in a narrow range of effective temperature. The observations were interpreted using intermediate and wide-band photoelectric colors, and differential curves of growth. Small scale differences in metal content between individual stars, or between groups of stars, may be estimated readily, provided that the possible effects of differential interstellar reddening are known or negligible and that the ranges in effective temperature and in gravity are small. The method of analysis begins to break down for dwarfs later than about Go in spectral type. As an effective temperature indicator it is essential to use a color insensitive to differential line-blanketing effects, such as a red−infrared color. No evidence was found for any composition variations among the individual cluster members. The magnesium abundance in the Hyades cluster was found to be greater than in the Coma cluster by a factor of 1.8. (auth)

5054 DECELERATION OF METAGALACTIC CLOUDS IN THE GALAXY. Puppi, G. (Univ., Bologna); Setti, G.; Woltjer, L. Nuovo Cimento (10), 45B: 252-3(Oct. 11, 1966).

A possibility is considered that a substantial part of the deceleration is due to the work done by the in-falling material on the relativistic cosmic-ray gas contained in the Galaxy. This hypothesis is supported by three considerations which are briefly discussed. (W.D.M.)

Atomic and Molecular Physics

Refer also to abstracts 4694, 4733, 5130, 5274, and 5375.

5055 (AD–637165) TIME-DEPENDENT DIFFUSE REFLECTION FROM SLABS WITH MULTIPLE SCATTERING. Bellman, R. E.; Kagiwada, H. H.; Kalaba, R. E. (RAND Corp., Santa Monica, Calif.). July 1966. Contract AF 49(638)-1700. 26p. (RM–5070-PR). CFSTI $3.00 cy, $0.65 mn.

The solution of the time-dependent multiple scattering problem for reflected radiation from homogeneous slabs with a delta-function input. The basic differential-integral equation for the Laplace transform of the reflected radiation is solved computationally. Then the intensity of the reflected radiation is calculated by means of a recently developed numerical procedure for the inversion of Laplace transforms. Sample numerical results are tabulated for five different albedos, for the time histories of the diffuse reflection function for seven incident angles, seven reflected angles, and a thickness of 1.0. (auth)

5056 (AD–637176) ELECTRIC DEFLECTION MOLECULAR BEAM APPARATUS WITH A MASS SPECTROMETRIC DETECTOR. Final Scientific Report. Greene, Frank T.; Milne, Thomas A. (Midwest Research Inst., Kansas City, Mo.). July 1966. Contract AF 49(638)-1568. 20p. (AFOSR–66-1716). CFSTI $3.00 cy, $0.65 mn.

A molecular beam apparatus for the measurement of dipole moments and polarizabilities by the electric deflection method was designed and is now essentially complete. A quadrupole mass filter is used as a detector. The system is completely bakeable to 400°C and uses modulated beam techniques for improved signal-to-noise ratios. (auth)

5057 (AD–637193) TEMPERATURE DEPENDENCE OF HELIUM TRANSFER CROSS SECTIONS. Scientific Report, January 1965–March 1966. St. John, Robert M.; Jobe, John D. (Oklahoma Univ. Research Inst., Norman). Apr. 1966. Contract AF-AFOSR-252-65. 48p. (AFOSR–66-1456). CFSTI $3.00 cy, $0.65 mn.

Helium gas at a pressure of 63 microns and variable temperature was excited by the impact of 100-eV electrons. At this pressure atomic collisions are plentiful and the excitation energy is thereby transferred from one state to another, primarily from singlet states to singlet and triplet D states. The "multiple-state" transfer process (transfer from N-singlet-P to nF and cascade from nF to lower singlet and triplet D states) is examined in light of the data acquired on the density of singlet P states for n from 3 through 8, singlet D states for n from 4 through 6, and triplet D states for n from 3 through 10. These data were acquired at 8 temperatures in the range from 300 to 1000°K. (auth)

5058 (AD–637241) COLLISION PROCESSES. Final Report. Clark, Kenneth C.; Geballe, Ronald (Washington Univ., Seattle. Dept. of Physics). July 19, 1966. Contract Nonr-477(32). 10p. CFSTI $3.00 cy, $0.65 mn.

A summary is given of studies involving the characteristics of ion−neutral gas collisions in which Lyman-alpha radiation is emitted. A list of publications generated under the contract is included. (TAB)

5059 (CEA-R-3075) GENERATION D'HARMONIQUES DE LA DEMI-FREQUENCE GIROMAGNETIQUE ELECTRONIQUE DANS UN SYSTEME "DOUBLE-FAISCEAU".. (The Generation of Harmonics of the Electron Cyclotron Half-Frequency in a Double-Beam Interaction Experiment). Olivain, Jack (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Sept. 1966. 102p. (In French). (EUR-3088.f). Dep. mn.

The generation of harmonics of the electron cyclotron half-frequency in a double-beam interaction experiment was studied. A theoretical discussion is presented in which the transverse velocity distributions are represented by Dirac delta functions. The experimental measurements show the structure of the waves generated, for the fundamental mode $[\omega = (\omega/2)ce]$, i.e., their azimuthal wave number, wave length, and radial profile of the oscillating potential, density and current. The quasi-electrostatic character of these waves was established from these results. Measurements were also made of the amplitudes and line widths of several harmonics as well as the growth rate of the first of them. Finally, a number of observations were made which show that nonlinear wave interactions play an important role in this system and which suggest an interpretation based on this mechanism for the generation of high-order harmonics. (auth)

5060 (IS–1451) ULTRASONIC WAVE PROPAGATION IN Mg_2Pb. Chung, P. L.; Danielson, G. C. (Ames Lab., Iowa). Sept. 1966. Contract W-7405-eng-82. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A resonance technique to determine the ultrasonic wave propagation constants in semiconductors was developed. The technique employs a standard Q meter. The longitudinal and transverse sound velocities of Mg_2Pb in the [100] and [110] directions were determined at room temperature. The elastic constants from these measurements were calculated to be $C_{11} = 7.16 \times 10^{11}$ d/cm², $C_{12} = 2.21 \times 10^{11}$ d/cm², and $C_{44} = 3.09 \times 10^{11}$ d/cm². The errors in these determinations of the elastic constants were estimated to be less than 1%. The interrelationship of the elastic constants suggests that Mg_2Pb probably has predominantly covalent bonds like the other three compounds in this family, Mg_2X (X = Si, Ge, Sn or Pb). (auth)

5061 (N-66-29462) COLLISION FREQUENCIES AND ENERGY TRANSFER ELECTRONS. Banks, Peter M. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). May 1, 1966. 41p. (NASA-CR-75889). CFSTI $3.00 cy, $0.65 mn.

The problem of elastic collisions and energy transfer between gases which have separate Maxwellian velocity distributions is studied. It is shown that the expression for the energy transfer rate obtained by Desloge for gases of arbitrary temperature and particle mass can be adapted into a convenient form which involves a ratio of the particle masses, the difference in the gas thermal energies, and a collision frequency for energy transfer. An analysis is made of the collision frequency in terms of an average momentum transfer cross section which is defined for conditions of thermal nonequilibrium. The general equations are specialized to consider the problem of elastic electron collisions in heavy particle gases. To obtain useful numerical expressions for electron–neutral particle collision frequencies and energy transfer rates, an analysis is made of the momentum transfer cross sections for N_2, O_2, O, H, and He. Calculations are also made of the Coulomb momentum transfer cross section, collision, frequency, and energy transfer rate. (auth)

5062 (N-66-29707) FORECAST FOR THEORETICAL CHEMISTRY. Hirschfelder, Joseph O. (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Mar. 28, 1966. 38p. (NASA-CR-75985; WIS-TCI-171). CFSTI $3.00 cy, $0.65 mn.

Application of molecular quantum mechanics and statistical mechanics in theoretical chemistry is emphasized. The use of Slater screening constants makes it possible to estimate the energy or almost any physical property of an atom. High-speed computers can be utilized to calculate the energy of a large number of diatomic and triatomic molecules; these molecular energies can then be applied to large scale calculations of potential energy surfaces and predicted chemical reaction rates. Potential energy surfaces can also be constructed by using the Born–Oppenheimer separation theory of electronic and nuclear motions in molecular beams. Quantum electrodynamic equations have to be considered for second order effects of nuclear magnetic resonance, laser optics, microwave line shapes, etc. The growth of crystals and the theory of nucleation are other fields of theoretical research that also requires statistical mechanics. (STAR)

5063 (N-66-32254) EXTENSIONS OF THE MOMENTUM TRANSFER THEOREM. Gerjuoy, E. (Pittsburgh Univ., Pa. Space Research Coordination Center). Jan. 28, 1966. 15p. (NASA-CR-76651; SRCC-26). CFSTI $3.00 cy, $0.65 mn.

Lippmann recently discussed the extension of the momentum transfer theorem to systems more complicated than the elastic or inelastic collisions of electrons with atomic hydrogen and to other observables so as to derive, e.g., an energy transfer theorem. He took exception to some remarks concerning the validity of the symbolic methods customarily used in scattering theory. These remarks, which proved the momentum transfer theorem for e–H collisions, were accurately quoted, but did not appear in his paper because they were not wholly defensible. Nevertheless some differences remain between Lippmann's and this author's views of the status of the momentum transfer theorem and its extensions. This paper is presented to make these differences explicit. (auth)

5064 (NYO-1932-113) NEW THEORETICAL VALUES FOR THE LAMB SHIFT. Soto, M. F. Jr. (Columbia Univ., New York). [1966]. Contract AT(30-1)-755. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A calculation was made to obtain the fourth-order radiative corrections to the energy levels of hydrogenic atoms. (M.O.W.)

5065 (NYO-3399-39) GROUP THEORY OF THE KEPLER PROBLEM. Sudarshan, E. C. G.; Mukunda, N.; O'Raifeartaigh, L. (Wisconsin Univ., Madison. Dept. of Physics. Syracuse Univ., N. Y. Dept. of Physics). [1965]. Contract AT(30-1)-3399. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The hydrogen atom is investigated from a group theoretical point of view, both in the classical and quantum mechanical cases. The positive and zero energy states, as well as the bound states, are investigated. (M.O.W.)

5066 (ORO-1316-17) POLARIZED ^3He TARGETS AND ION SOURCES BY OPTICAL PUMPING. Walters, G. K. (Rice Univ., Houston, Tex.). [1966]. Contract AT(40-1)-1316. 22p. (CONF-661205-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Polarized Targets and Sources, Saclay, France.

Sizable nuclear spin polarization can be induced in low-density gaseous ^3He at room temperature by optical pumping techniques. A number of polarized ^3He targets suitable for use in low-energy nuclear scattering experiments were prepared using this technique. The targets are relatively simple and inexpensive to prepare and operate, and they are spectroscopically pure; their primary shortcoming is low density, about 2×10^{17} helium atoms per cc being the current practical upper limit. However, significantly enhanced steady-state nuclear polarization has very recently been achieved in liquid ^3He by optically pumping the vapor above it; future improvements in this method may lead to useful dense polarized ^3He targets. Considerable progress was also made toward realization of a usable polarized $^3He^+$ ion beam. Ion currents of the order of a microampere were extracted from optically pumped ^3He gas in a specially designed rf discharge ion source. (auth)

5067 (UCRL-16405(Rev.)) SECONDARY-ELECTRON DISTRIBUTION FOR HEAVY IONS. Oda, Nobuo; Lyman, John T. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1966. Contract W-7405-eng-48. 28p. (CONF-650924-6(Rev.)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Workshop Conference on Space Radiation Biology, Berkeley, Calif.

Two kinds of approaches to the δ-ray correction for heavy ions are discussed: "space-averaged picture" and "extended-track picture." The fundamental quantity for the "space-averaged picture" is the differential flux (slowing-down spectrum) $\phi_\delta(E)$ of δ rays. Experimental results are presented on the energy spectra and absolute yield values of the low-energy part of $\phi_\delta(E)$. The most interesting results are as follows: (i) when the velocities of primary ions are the same, the yields for each kind of ion are proportional to dE/dx and, (ii) when the velocities are different for each kind of ion, the specific yield for higher velocity is higher than that for lower velocity. The discussion of several related problems suggests the importance of studies on the behavior of energy spectra of the secondary-electron flux. (auth)

5068 (UCRL-16765) CROSS SECTIONS FOR ELECTRON CAPTURE BY FAST PROTONS IN H_2, He, N_2, Ar. Welsh, Leland Merritt (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 30, 1966. Contract W-7405-eng-48. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Measurements were made of cross sections for electron capture by protons, from 440 keV to 13.75 MeV in N_2 and in Ar; to 5.41 MeV in He; and to 2.45 MeV in H_2. These results are presented, along with electron-loss cross sections for the same gases at 1.027 and 2.44 MeV. The measurements were carried out through analysis of particle beam composition after exit from a gas target of known composition and thickness. The beam was separated magnetically, and the charged and neutral components were detected by Faraday cup and scintillator, respectively. (auth)

5069 (UCRL-17175) COLLISION-INDUCED MIXING IN THE 5^2P/sub 3/2/ STATE OF RUBIDIUM AND THE 6^2P/sub 3/2/ STATE OF CESIUM. Yellin, Joseph (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 4, 1966. Contract W-7405-eng-48. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Alkali-metal vapors of rubidium and cesium were optically pumped, with the D_2 component of the resonance radiation and the reversal of the ground-state polarization observed as a function of buffer-gas pressure. It is well known that when complete mixing occurs in the $^2P_{1/2}$ state, the polarization achieved in the ground state ($^2S_{1/2}$) is opposite to that obtained with the D_1 component of the resonance radiation when circularly polarized light is used. However, in the absence of mixing in the $^2P_{1/2}$ state, the sign of the polarization is the same for both D_1 and D_2 light. For some finite degree of mixing of the $^2P_{1/2}$ state, the equilibrium electronic polarization vanishes. From the null points observed in the D_2 pumping signal vs buffer-gas-pressure curve, cross sections were determined for collisional disorientation of the $^2P_{1/2}$ state of a polarized Rb or Cs atom. (auth)

5070 CALCULATION OF THE PHOTOIONIZATION CROSS SECTIONS FOR NITROGEN AND OXYGEN ATOMS AND IONS IN A STATE OF EXCITATION. Nikolaev, V. M.; Plastinin, Yu. A. pp 34-40 of Issledovaniia po Fizicheskoi Gazodinamike. Predvoditelev, A. S. (ed.). Moscow, Izdatelstvo Nauka, 1966. (In Russian).

Results are presented of the calculation of the photoionization cross sections of N and O atoms in the region $\lambda \geq 0.12\ \mu$ by the quantum defect method. The NI, NII, OI, and OII cross sections at 8000, 9000, 10,000, 11,000, 12,000, 14,000, 16,000, 18,000, and 20,000°K are shown in diagram form. (Inst. Aero. Abstr.)

5071 TWO PHOTON TRANSITIONS IN ANTHRACENE. Polacco, E. (Univ., Pisa, Italy). Nuovo Cimento (1), 3: Suppl., 1108-16(1965). (In Italian).

In the study of two-photon transitions in anthracene only optical photons are considered. The formula for the E1 dipole electric transitions to a photon is given. The theory commonly used for the E1 transitions is summarized. The results of some experiments made on anthracene crystals are recorded and the results are analyzed. The results confirm the hypothesis of multipolar transitions. The results also showed the deceiving role of coherents of the incident radiation and the contribution of the multipolar terms. (J.S.R.)

5072 PRESSURE DISSOCIATION AND THE HYDROGEN MOLECULAR ION. **Vardya, M. S. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Mon. Notic. Roy. Astron. Soc., 134: 183-8(1966).**

The partition functions for the hydrogen molecular ion, with an estimate of pressure dependence included, were calculated, using an extension of the Heitler–London theory. The partition functions were used to evaluate the equilibrium constants and internal energies for H_2^+ as a function of temperature and pressure. Tables of partition functions, equilibrium constants, and internal energies are given for T = 3,000 to 25,000°K and for pressures as high as 2×10^{10} dyne/cm^2. (auth)

5073 CHARGE DENSITIES AT THE NUCLEUS. **Malli, G.; Fraga, S. (Univ. of Alberta, Edmonton). Can. J. Phys., 44: 3131-5(Dec. 1966).**

The electronic densities and their derivatives at the nucleus for neutral atoms, positive ions, and negative ions (for Z = 2–36) were evaluated, using analytical Hartree–Fock functions. These values confirm the discussion given in regard to the selection of the basis sets to be used in the expansion of the orbitals. (auth)

5074 INCOHERENT SCATTERING OF 662-keV GAMMA RAYS BY K-SHELL ELECTRONS OF Pb, Ta, Sm, AND Sn. **Ramalinga Reddy, A.; Lakshminarayana, V.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Pure Appl. Phys., 4: 371-7(Oct. 1966).**

The differential cross sections $[(d\sigma K/d\Omega)(\theta)]$ for the incoherent scattering of 662-keV gamma rays by K-shell electrons of lead, tantalum, samarium and tin are determined employing a fast-slow type of coincidence NaI(Tl) scintillation spectrometer with an effective resolving time of 60 nsec. These cross sections are compared with the Klein-Nishina cross sections $[(d\sigma F/d\Omega)(\theta)]$ computed for electrons that are initially free and stationary. The results agree qualitatively with the computations based on the incoherent scattering function $S(h\nu,\theta,Z)$. The energy spectra of the photons inelastically scattered by the K-shell electrons of tantalum at scattering angles of 60° and 90° are measured and the cross sections are determined. The differential incoherent scattering cross sections are found to have a Z dependence of the form Z^n, where the exponent n varies from −0.469 to +0.620 for the scattering angles ranging from 30° to 130°. (auth)

5075 MERGING BEAMS, A DIFFERENT APPROACH TO COLLISION CROSS SECTION MEASUREMENTS. **Trujillo, S. M.; Neynaber, R. H.; Rothe, Erhard W. (General Dynamics/Convair, San Diego, Calif.). Rev. Sci. Instrum., 37: 1655-61(Dec. 1966).**

A different approach has been developed to measure two-body collision cross sections in the energy range from thermal to several hundred electron volts. Two molecular beams are merged and move in the same direction along a common axis. Ion–neutral reactions are discussed, but the techniques could also be used for ion–ion and neutral–neutral collisions. Advantages of the merging beams technique over conventional beam-gas and crossed-beam methods include accessibility (with good energy resolution) to the energy region from a few tenths of one to a few electron volts; the possibility of measuring cross sections for two general, labile species; and relative ease in collecting and detecting products for total reaction cross section measurements. The principles of the method and details of the instrument are discussed. A cross section for the resonant charge transfer of Ar was measured. Reasonable agreement with some previous measurements, and other tests, indicate that the basic principles of a merging beams technique are valid and that the apparatus performs satisfactorily. (auth)

5076 MONOCHROMATIZATION OF ELECTRON BREMSSTRAHLUNG SPECTRA. **Korobochko, Yu. S. (Leningrad Polytechnic Inst.). Zh. Tekh. Fiz., 36: 1394-8(Aug. 1966). (In Russian).**

The coherent peaks in the bremsstrahlung spectrum produced by high-energy electrons incident on a thin single crystal target are discussed. Moderately high-energy (tens of MeV) incident electrons are considered, rather than the very high energies treated in the cited references. The process of coherent bremsstrahlung is treated as a particular case of electron diffraction on a periodic structure, and the sum over the reciprocal lattice points is replaced, as an approximation, by an integration, after the reciprocal lattice points have been smeared over planes of constant momentum transfer. The width of the coherent peak is taken into account by ascribing a finite thickness to the reciprocal lattice plane. The following factors contributing to the width of the peak are considered; the finite thickness of the target; the finite curvature of the Ewald sphere; misalignment of the target or its mosaic structure; lack of perfect collimation of the electron beam; the finite solid angle of observation; and multiple scattering of electrons in the target. The effects of these factors are estimated, and it is concluded that one can achieve a relative dispersion in the coherent peak of the momentum transfer to the lattice of the order of 0.01 by using a target of the order of one micron thick and keeping the vertex angle of the cone of observation less than 0.1/E, where E is the incident electron energy in terms of the electron rest energy. (ATD)

5077 COLLECTIVE OSCILLATIONS OF THE ELECTRON SHELLS OF AN ATOM. **Amusya, M. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1409-15(Aug. 1966). (In Russian).**

Green's function is employed to discuss the excitation of plasma oscillations (production of plasmons, i.e., of bound states of electron-hole pairs) in the electron shells of an atom. It is shown that conditions for the existence of plasmons are fulfilled in the electron shells of practically all atoms with atomic numbers greater than about 18 and that the energy separation of the different shells is sufficient to make possible the existence of solutions that can be regarded as approximately representing independent oscillations of separate shells. Approximate expressions are derived for the cross sections for excitation of plasmons in atomic electron shells by electron impact (this cross section is of the order of 10^{-17} cm^2) and by impact of heavy particles, and the decay of atomic electron shell plasmons is discussed briefly. (ATD)

5078 CONDITIONS FOR SPECULAR REFLECTION OF ATOMIC BEAMS FROM CRYSTAL SURFACES. **Raigorodskii, L. D. (Leningrad Shipbuilding Inst.). Zh. Tekh. Fiz., 36: 1489-91(Aug. 1966). (In Russian).**

From a short and relatively simple wave mechanical argument it is concluded that although the following two conditions are necessary for specular reflection of atomic beams from crystal surfaces, they are not sufficient: (1) the components in the direction of the incident beam of the heights of the surface irregularities of the reflector must be small compared with the de Broglie wavelength of the incident atoms; and (2) the incident atoms must spend only a short time on the surface of the reflector. It is concluded that the reflection will be maximum when the Bragg condition between the de Broglie wavelength, the distance between the lattice planes, and the angle of incidence is fulfilled. (ATD)

5079 IMAGINARY PART OF THE OPTICAL POTENTIAL FOR A MANY-ELECTRON ATOM. **Amusya, M. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1416-25(Aug. 1966). (In Russian).**

The concepts of the optical model are used to discuss the inelastic interaction of an electron with an atom. The real part of the optical potential is regarded as given with good approximation by the Hartree–Fock potential, and the imaginary part is calculated with the aid of the one-particle Green's function for a free particle. In this calculation the "statistical approximation" is employed, i.e., the processes taking place at a point where the particle density has a given value are assumed to be the same as those that would take place in an infinite medium of the same density. In this approximation the quantum effects associated with the noncommutativity of the coordinate and momentum operators are neglected. It is assumed that the electron density within the atom is high (that the Fermi momentum is large compared with a certain quantity proportional to the square of the electron charge — it is shown that this condition is fulfilled in moderately heavy atoms), and the corresponding expression for the imaginary part of the optical potential as an integral involving the Green's function and a certain effective potential is taken from an earlier paper. This integral is evaluated for the three particular cases when the incident electron momentum is much greater than, nearly equal to, or much smaller than the Fermi momentum. At high incident electron energies E the imaginary part of the optical potential is proportional to $E^{-½}\log E$, and at low energies it is proportional to $(E - \mu)^2$, where μ is the chemical potential of the atom. The dependence of the optical potential on the distance r from the nucleus was calculated for the mercury atom and is presented graphically for several values of E. For low values of E the imaginary part of the optical potential is large only near the surface of the atom. Ionization of atoms by electron impact and the excitation in them of plasma oscillations (production of bound states of electron-hole pairs) are discussed. It is proposed that there be explored a model in which the calculated E dependence of the imaginary part of the optical potential is retained but its r dependence is determined phenomenologically. Such an investigation should enable one to assess the significance of the quantum corrections that have been neglected. (ATD)

5080 HYSTERESIS AND VIRTUAL CATHODE FORMATION IN ELECTRON BEAMS. Czarczynski, W.; Ryley, J. E.; Gambling, W. A. (Univ. of Southampton, Eng.). Int. J. Electron., 21: 51-62(July 1966).

An investigation is reported of virtual cathode formation and hysteresis effects in electron beams produced by microwave low-noise electron guns in the presence of a strong longitudinal magnetic field. It is shown that, contrary to earlier suggestions, positive ions are not necessary for the formation of a hysteresis loop but they may greatly affect its size. Under certain conditions more than one virtual cathode may form, giving rise to additional effects. (auth)

5081 EIGENFUNCTIONS OF THE HYDROGEN ATOM IN MOMENTUM SPACE. Klein, James J. (Univ. of Calgary, Alberta). Amer. J. Phys., 34: 1039-42(Nov. 1966).

The Schrödinger problem of the hydrogen atom is solved using toroidal coordinates in momentum space. The wavefunctions are expressible in terms of Jacobi polynomials and ordinary trigonometric functions. (auth)

5082 ANNIHILATION OF POSITRONS BY ELECTRONS IN PLASTICALLY DEFORMED METALS WITH bcc LATTICE. Dekhtyar, I. Ya.; Mikhalenkov, V. S.; Sakharova, S. G. (Inst. of Metal Physics, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 168: 785-7(June 1, 1966). (In Russian).

A previous investigation of annihilation spectra in plastically deformed metals discloses changes in the electron energy spectrum. Results obtained for Ta, Nb, Fe, Fe + 0.63% Al, and Fe + 1.08% Al solid solutions are reported. The procedure used to obtain the annihilation spectra was described earlier (Vopr. fiz. metal. i metallovedeniya, no. 12: 46(1961)). The apparatus was modified to provide accumulation of larger statistical material. The angular distribution of the annihilation photons was plotted first for the stressed and then for the annealed material. The stress was produced by rolling in two mutually perpendicular directions and the strain was 75 to 80% in all samples. The results indicate that the s- and d-electrons become redistributed in the distortion field around the dislocations. Proof that the observed change in shape of the annihilation spectra is due to dislocations and not to point defects is the fact that annealing demonstrates these changes to occur at temperatures corresponding to intense dislocation. The elastic properties of the metal govern the maximum polarization, the excess dislocation charge, and the relative change of the annihilation rates, so that the measurement of the spectra yields new data on the electronic nature of defects of the dislocation type. The maximum intensity of the spectrum is increased by the deformation, but the half-width of the annihilation curve decreases. Alloying with aluminum, by affecting the stacking-fault energy, increases the polarization, but there are not enough data to explain this fact. Nor are the data sufficient to explain the specific features of the different crystal structures and their relation to the annihilation spectra. (ATD)

5083 SCATTERING OF ELECTRONS BY A SHORT-RANGE FORCE CENTER IN A CONSTANT AND HOMOGENEOUS MAGNETIC FIELD. Ternov, I. M.; Bagrov, V. G.; Rzaev, R. A. (Moscow State Univ.). Izv. Vyysh. Ucheb. Zaved., Fiz., No. 2, 111-18(1966). (In Russian).

The spin flip of an electron moving in a magnetic field and scattered by short-range centers such as a Yukawa potential was examined. The wave function of such an electron was obtained with account taken of the fact that this wave function must also satisfy the equation of the eigenvalues of one of the electron-spin polarization operators. The resultant equation was used to obtain the change in the electron spin orientation in the Born approximation. An expression was obtained for the total scattering probability, summed and integrated over all the quantities except the eigenvalues of the spin operators. Only the scattering probability of transversely polarized electrons is of practical interest, since the probability of longitudinal electrons does not differ from that of free electrons. Particular attention was therefore paid to the behavior of the spin projection on the direction of the magnetic field. Approximate expressions were obtained for this probability in several limiting cases. The results show that there is no preferred directivity in the spin flip process. (ATD)

5084 LOW-ENERGY SCATTERING OF ELECTRONS BY ATOMIC POTENTIALS WITH LONG-RANGE r^{-4} TAIL. Gupta, S. B.; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 40: 333-44(June 1966).

Following Spector (1964), an expression for the S-matrix in the case of an attractive inverse fourth-power potential was obtained. An effective-range formula for an atomic potential with r^{-4} tail was also derived. A general expression for phase shifts η_l for different angular momenta, l, is given for an atomic potential which is represented by a screened Coulomb potential of Allis and Morse type when r is small and the long-range r^{-4} potential when r is large. Numerical results are presented for η_0 for low-energy e^-—He collision. The effect of exchange was neglected. (auth)

5085 KINETIC THEORY AND COLLISIONAL DETACHMENT. Banks, Peter M. (HRB-Singer, Inc., State College, Pa. Pennsylvania State Univ., State College). Radio Sci., 1: 1293-6(Nov. 1966).

The work of Pierce defining the role of collision energy considerations in the temperature dependence of negative ion collisional detachment was altered by Arnold on the basis of a more exact gas kinetic approach valid for elastic spheres. A reexamination of this work is made here using gas kinetic equations with an arbitrary collision cross section. It is found that while the corrections of Arnold apply to a modified elastic sphere expression, the introduction of an ion—molecule interaction based upon a polarization force leads to a temperature dependence for collisional detachment which is the same as that originally given by Pierce. A difference is noted, however, in that the present expression involves only the neutral gas polarizability as a characteristic of the ion—neutral interaction, removing the previous necessity of making separate evaluations of the collision radii and ion and molecule free paths. Using the data of Pack and Phelps an expression for 0_2^- collisional detachment is derived as $D/n(n) = 4.2 \times 10^{-12}(5000/T)^{1/2} \exp \{-5000/T\}$ cm^3 sec^{-1}. (auth)

5086 EFFECT OF AN ELECTRONIC PSEUDOCHARGE DISTRIBUTION ON HYDROGEN-LIKE ATOMS. Sakitt, Barbara; Feinberg, Gerald (Columbia Univ., New York). Phys. Rev., 151: 1341-2(Nov. 25, 1966).

The pseudocharge or anapole is an electromagnetic interaction which is invariant under time reversal and odd under parity. The effect in hydrogen-like atoms of an electronic pseudocharge distribution is calculated. Upper limits for the pseudocharge mean-square radius are obtained by comparing the results with experiments on the Lamb shift and the lifetime of metastable hydrogen-like atoms. (auth)

5087 NUCLEAR SCATTERING LENGTHS FROM THE SPECTROSCOPY OF MUONIC MOLECULES. Zwanziger, Daniel (New York Univ.). Phys. Rev., 151: 1337-40(Nov. 25, 1966).

The shift in energy levels of μ molecules produced by the nuclear interaction energy was calculated. It is proportional to the probability of coincidence of the two nuclei and to their zero-energy scattering length. In pμp it is 0.01 eV; in pμd it is 0.005 eV. The effect may be detected by measuring the hyperfine splitting of pμd, of which it is a considerable fraction, and a null test for its presence is given. Its magnitude yields the difference of the nuclear scattering lengths in different spin states. As a by-product of our analysis of the pμd hyperfine splitting, the possibility it presents, as compared to pμp, of studying the μ-p spin-spin interaction is discussed, which is a sensitive test of quantum electrodynamics. (auth)

5088 LOWER BOUND ENERGY CALCULATIONS FOR H_2^+. Walmsley, Mary; Coulson, C. A. (Mathematical Inst., Oxford). Proc. Cambridge Phil. Soc., 62: 769-76(Oct. 1966).

Two different calculations are made of lower bounds for the electronic energy of H_2^+. In the first the method of truncated Hamiltonians due to Bazley and Fox is adapted in such a way that the nuclear charge rather than the energy becomes the eigenvalue. Lower bounds are calculated for the energies of the six lowest σ_g and six lowest σ_u states, as well as of the three lowest of both π_g and π_u symmetries. This approach gives better convergence than when the energy is used as eigenvalue. In the second calculation the method of Temple and Kato is shown to give a satisfactory value for the energy of the ground state, provided that some necessary knowledge of the energy of the first excited state is available. (auth)

5089 PLASMON PHOTOELECTRIC AND SECONDARY ELECTRON EMISSION. Gornyi, N. B. (Bonch-Bruevich Electrotechnical Communications Inst., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 1535-7(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1939-42(June 1966).

Experimental data are discussed on the photoelectric—secondary electron emission indicating a considerable role of the collective excitations of interacting electrons (plasmon oscillations) in these phenomena. (M.O.W.)

5090 RECONSTRUCTION OF THE SCATTERING POTENTIAL FROM THE INELASTIC SCATTERING OF CHARGED PARTICLES FROM CRYSTALS. de Wames, R. E.; Hall, W. F. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Lett., 23: 649-50(Dec. 12, 1966).

The potential of interaction between charged particles and lattice atoms is shown to be recoverable from the single-phonon scattering cross section, which recent advances in the measurement of small energy losses have made experimentally accessible. (auth)

5091 PARAMAGNETIC RESONANCE OF FREE SILVER ATOMS STABILIZED ON SOLID SURFACES. Zhitnikov, R. A.; Paugurt, A. P. (Ioffe Inst. of Physics and Tech., Leningrad. Kalinin Polytechnical Inst., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 1429-35(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1796-1806(June 1966).

X-ray irradiation at 77°K of silica gels, on whose surfaces silver ions were adsorbed, was used to obtain free silver atoms stabilized on these solid surfaces. The stabilized atoms were investigated by the paramagnetic-resonance method. The mechanism of the formation of silver atoms stabilized on a surface is discussed, and the nature of their interaction with the surface is considered. (auth)

5092 CORRELATION BETWEEN OPTICAL AND RADIO EMISSION FROM EXTENSIVE AIR SHOWERS AT LARGE ZENITH ANGLES. McBreen, B.; O'Mongain, E. P.; Porter, N. A.; Slevin, P. J. (University Coll., Dublin). Phys. Lett., 23: 677-8(Dec. 12, 1966).

Evidence was found for correlation between optical and radio emission from extensive air showers at large zenith angles, using a Cherenkov optical detector and wide-band radio system. (auth)

Cosmic Radiation

Refer also to abstracts 4706 and 5164.

5093 (INSJ-100) SPARK CHAMBER PICTURES OF AIR SHOWERS. Akiyama, H.; Ishikawa, F.; Matano, T.; Nagano, M.; Shibata, S.; Suga, K.; Takano, M.; Uchino, K. (Institute of Nuclear Study, Tokyo Univ. (Japan)). Sept. 19, 1966. 24p. Dep. mn.

The spark chamber and EAS array used to study the structure of EAS cores since April 1965 are described. Single cores, multiple cores, and inclined air showers probably produced by muons are discussed briefly, and typical pictures are shown. (A.G.W.)

5094 (N-66-30336) PROPAGATION OF COSMIC RAY NUCLEI IN COSMIC RAY SOURCES, INTERSTELLAR SPACE AND SOLAR SYSTEM. Durgaprasad, N. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1966. 32p. (NASA-TM-X-55513; X-611-66-114). CFSTI $3.00 cy, $0.65 mn.

Simultaneous intensity measurements of protons, helium, and heavy nuclei can be used to describe the effects on the source energy spectrum of solar modulation and diffusion occurring in source regions and in interstellar space. The energy spectra of heavy nuclei ($Z \geq 10$) were determined in the energy region 200 to 700 MeV/nucleon for the year 1961 and compared with similar data obtained for protons, α particles, and heavy nuclei during the years 1961 and 1963. The results indicated that the observed intensities could be adequately explained by the following: (a) the modulating mechanism as described by a model given by Parker compared with the electric deceleration model of modulation, (b) a source differential rigidity or total energy spectrum rather than a kinetic energy spectrum having an exponent of 2.35 (as derived from experimental data available in the high-energy range 10^{10} to 10^{14} eV/nucleon, that is little affected by solar modulation) and (c) a path length of interstellar matter traversed that is decreasing or constant with decreasing energy for energies $\lesssim$ 15 GeV/nucleon. (auth)

5095 EXPERIMENTAL EVALUATION OF VARIOUS RIGIDITY MODELS. Kenney, J. F. (Boeing Co., Seattle); Gauger, J.; Shea, M. A.; Smart, D. F. J. Geophys. Res., 71: 5635-42(Dec. 1, 1966).

Atmospheric cosmic-ray fluxes were measured over large portions of the globe on a series of flights of a United States Air Force jet aircraft. The measured fluxes were plotted as a function of the vertical cutoff rigidity for several different models. The rigorous trajectory calculations of Shea et al., give good agreement with the counting rates. The Makino model also orders these data equally well and therefore must be within a few per cent of the value determined by rigorous orbit calculations taken over the portions of the globe covered in this survey. The other models are demonstrably worse, and a discussion of where these models are inadequate is given. Particular attention is paid to the use of the L parameter as a substitute for rigorous integration procedures. It is shown both experimentally and theoretically that the L parameter is not a good demographic parameter for galactic cosmic radiation at the lower latitudes, but it should be sufficiently accurate at higher latitudes for most purposes. (auth)

5096 THE ENERGY SPECTRUM OF COSMIC-RAY HEAVY NUCLEI OF CHARGE $Z \geq 10$ DURING A SOLAR QUIET TIME IN JULY 1961. Durgaprasad, N. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 71: 5625-33(Dec. 1, 1966).

The energy spectrum of heavy nuclei (charge $Z \geq 10$) was determined, in the energy interval from 200 to 700 MeV/nucleon, using a stack of nuclear emulsions, exposed on July 8, 1961, at a mean altitude of ~2.4 g/cm^2 of residual atmospheric depth on a balloon flown from Fort Churchill, Manitoba. The flight was preceded by a period of three months of low solar and geophysical activity. The charge and energy spectra were obtained principally from tracks of particles that ended in the detector by a combination of range and δ-ray density measurements. A second charge estimation for particles that stop in the emulsion was made from integral δ-ray counts as a function of range. The energy spectrum was measured up to 700 MeV/nucleon by also taking into consideration the tracks that pass through or interact within the stack using a combination of δ-ray density and multiple scattering measurements that determine the charge and energy of the nuclei. This energy spectrum was combined with the spectra measured for protons and helium nuclei in the same flight and with similar data obtained during 1963 with a view of arriving at a better understanding on the propagation of cosmic-ray nuclei in source regions, interstellar space, and the solar system. (auth)

5097 OBSERVATIONS OF THE ISOTROPIC COMPONENT OF COSMIC X RAYS AT BALLOON ALTITUDE. Hudson, H. S.; Primbsch, J. H.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res., 71: 5665-8(Dec. 1, 1966).

The isotropic component of cosmic X-ray flux between 20 and 70 keV was determined from measurements made with balloon-borne X-ray telescopes. In this energy range the spectrum is characterized by $\gamma = 2.7^{+1.7}_{-0.6}$ in the distribution $N(h\nu) = k(h\nu)^{-\gamma}$. The measured flux at 40 keV was $0.014^{+0.008}_{-0.003}$ photons (cm^2 sec sterad kev)$^{-1}$. The observations by Ghielmetti, Becerra, Godel, Heredia, and Roederer of an X-ray influx over the South Atlantic geomagnetic anomaly can probably be explained by the cosmic primary X rays. (auth)

5098 SOME OBSERVATIONS OF THE COSMIC-RAY EVENT OF APRIL 18, 1965. Houston, Robert E.; Earhart, J. Ronald (Univ. of New Hampshire, Durham). J. Geophys. Res., 71: 5762-4 (Dec. 1, 1966).

On April 18, 1965, the 22-MHz riometer located at Durham, New Hampshire, indicated an unusual disturbance. Tracings of some of the records of this event are shown. Station riometer data available for the period 0500 to 1000 on April 18, 1965, are listed. Plots of average counts per hour in a 24-hour day versus day of the month for cosmic-ray data obtained from neutron monitors located at seven stations around the earth are shown. Also, the time sequence of the horizontal component of the earth's magnetic field for the magnetometer located at Fredericksburg, Virginia, is included. (J.H.M.)

5099 COSMIC-RAY ELECTRON LIFETIMES IN THE GALACTIC DISK AND HALO. Ramaty, Reuven; Lingenfelter, Richard E. (Univ. of California, Los Angeles). Phys. Rev. Lett., 17: 1230-2 (Dec. 12, 1966).

Recent measurements of cosmic-ray electrons of 12 to 350 BeV, indicate that their differential energy spectrum can be fitted by a power law with spectral index of 2.1 ± 0.2. This index is the same as that found at energies of a few BeV, which seems to contradict the expected steepening of the spectrum because of synchrotron and inverse Compton losses. As a result of this discrepancy, Daniel and Stephens (Phys. Rev. Letters, 17: 935(1966)) concluded that either the 3°K black-body radiation does not exist or there is an additional high-energy source of electrons with spectral index of 1.1. It is proposed instead that the observed high-energy electron spectrum results from a cosmic-ray mean lifetime in the galactic disk that is shorter than the lifetime against radiation losses by these electrons, but long enough to establish a measurable equilibrium flux. (W.D.M.)

5100 DETERMINATION OF THE FLUX OF PRIMARY COSMIC RAY HYDROGEN AND HELIUM NUCLEI NEAR THE GEOMAGNETIC EQUATOR USING NUCLEAR EMULSIONS. PART II. FLUX OF HELIUM NUCLEI ON MARCH 24, 1960 AT GEOMAGNETIC LATITUDE 7.6 DEG N. Kajarekar, P. J. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 64: 123-7(Sept. 1966).

The flux of helium nuclei of the primary cosmic radiation at the top of the atmosphere was determined over Hyderabad, India, at a time of high solar activity in the 11-year cycle, namely March 24, 1960. The flux value was found to be 17.9 ± 1.9 helium nuclei per m^2 sec sterad corresponding to a vertical geomagnetic cut off energy of 7.5 GeV/nucleon. This result when compared with other observations made near the geomagnetic equator shows that the solar modulation effects, if any, at rigidities >16 GV should be $\lesssim$10% only. (auth)

5101 ROLE OF THE GEOMETRY OF THE SOLAR SYSTEM IN GROUND OBSERVATIONS OF COSMIC-RAY VARIATIONS. Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 181-8 (1966).

Translated from Geomagn. Aeronomiya, 6: 231-40(1966).

It is shown that allowance for the mutual position of the earth and sun and of their axes of rotation makes it possible to obtain additional information on the angular distribution and transverse gradient of cosmic-ray intensity in interplanetary space. Geometric effects leading to the modulation of solar-diurnal and stellar-diurnal variations, and the appearance of annual and semi-annual cosmic-ray variations are examined. (auth)

5102 ISOTROPIZATION OF COSMIC RAYS. Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Soviet Astron.-AJ (Engl. Transl.), 10: 419-28(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 528-42(May-June 1966).

The role of plasma effects in isotropizing cosmic rays is discussed. Two isotropization mechanisms are considered: cosmic-ray beam instability, and scattering of cosmic rays by turbulent plasma pulsations. The conditions necessary for isotropization by beam instability are described. In the initial development of beam instability very large increments arise, which would isotropize cosmic rays in a relatively short time if not prevented by nonlinear interaction effects between the oscillations generated. For relativistic cosmic-ray particles nonlinear effects will, in cases of practical interest, tend to eliminate the instability and arrest the isotropization at very low values for the energy transferred by cosmic rays to plasma oscillations. This process will occur if the plasma ions have a nearly Maxwellian equilibrium distribution. However, if ion beams occur with mean velocities close to the thermal-ion velocity and densities close to the thermal-ion density, the nonlinear effects will facilitate isotropization. Analysis shows that the problem of isotropization by beam instability is closely related to the problem of ion motion, which is often controlled by gravitational forces. Isotropization may therefore be promoted by galactic rotation, gravitational instability, the plasma inhomogeneities that often occur in supernova envelopes and other objects (ion drifts arise in plasma inhomogeneities). Cosmic-ray isotropization through scattering by turbulent plasma pulsations is highly efficient. The treatment of this mechanism assumes that the turbulent pulsations are excited by sources other than cosmic rays. Isotropization effects resulting from scattering of cosmic rays by high-frequency turbulent pulsations and by hydrodynamic pulsations are considered. The relative contribution of hydrodynamic and high-frequency plasma turbulence is estimated. It is important to note that these isotropization mechanisms do not necessarily entail magnetic fields, and particularly that they are local mechanisms. (auth)

5103 PRIMARY COSMIC-RAY SPECTRUM AT HIGH ENERGIES AND SPECTRA OF γ RAYS AND MUONS IN THE ATMOSPHERE. Pal, Yash; Tandon, S. N. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 151: 1071-5(Nov. 25, 1966).

The shape of the primary cosmic-ray spectrum at very high energies and its connection with the spectra of high-energy γ-rays and muons in the atmosphere are discussed. Using a simple formulation for calculating secondary spectra arising from power-law primary spectra cutoff at arbitrary points, it is shown that a specific two-component model for the primary spectrum explains the present observations on the high-energy γ-ray spectrum at all altitudes and the muon spectrum at sea level, without invoking any change in the character of the interactions at high energies. Such a spectrum is also consistent with air-shower observations. (auth)

5104 ASTRONOMY OF THE NEUTRINO. Masani, A. (Osservatorio Astronomico di Brera, Milan); Gallino, R.; Silvestro, G. Nuovo Cimento (1), 3: Suppl., 934-1028(1965). (In Italian).

The most significant developments in the field of neutrino astronomy are summarized. The production of low-energy neutrinos at the interior of stars, the detectability of low-energy neutrinos, and high-energy neutrinos produced by cosmic radiation are considered. (J.S.R.)

5105 COMPARISON OF SPECTRAL CHARACTERISTICS OF LONG-TERM AND SHORT-TERM CHANGES IN COSMIC-RAY INTENSITY. Kane, R. P. (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 45B: 132-7(Oct. 11, 1966).

Spectral characteristics of the long-term change of cosmic-ray intensity in the period 1963–65 are compared with that of the Forbush decrease which occurred in September 1963. For a spectrum of type E^{-m}, the long-term change has an exponent m of about 1.1 for 1963 increasing to about 1.5 by 1964 end. In contrast, the Sept. 1963 Forbush decrease has m about 0.7 indicating a much flatter energy-dependence. (auth)

5106 IONIZATION OF THE LOWER IONOSPHERE BY COSMIC RAYS. Velinov, P. (Inst. of Geophysics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 281-4 (1966). (In Russian).

The formula for electron production by cosmic rays was expanded for the lower-energy cosmic rays which are produced at geomagnetic latitude larger than $\lambda_m \approx 55°$. (R.V.J.)

Direct Energy Conversion

5107 (AECL-Pak-Lib/15) SOLAR ENERGY. A Bibliography of Selected Literature. Rafique, M. M.; Afzal, F. A.; Saleem, M. (Atomic Energy Centre, Lahore (Pakistan)). Sept. 1966. 79p. Dep. mn.

A total of 907 references to unclassified reports and the published literature is presented on the subject of solar energy. (auth)

5108 (JPL-TR-32-981) JPL FISSION–ELECTRIC CELL EXPERIMENT. Krieve, W. F. (Jet Propulsion Lab., Pasadena, Calif.). Nov. 15, 1966. Contract NAS 7-100. 20p.

A series of experiments was performed with two different large concentric cylinder fission–electric cells in thermal neutron fluxes up to 10^{10} n/cm^2 sec at the General Electric Nuclear Test Reactor. A clearcut demonstration of the fission–electric cell concept was achieved. Fission fragment currents up to 10^{-8} A, which were in good agreement with calculated values, were observed. Magnetic field suppression of electron countercurrents was completely successful. Electrostatic grid suppression of the extraneous electrons was much less effective. The original cell configuration, in which the anode cylinder surrounded the inner cathode cylinder, achieved stable potentials of approximately one kV. The modified configuration, in which the cathode with electron sweep rings surrounded the anode, reached potentials as great as 21 kV, but was not stable above 4 kV. (auth)

5109 (N-66-29520) ADVANCEMENT IN THE STATE OF THE ART IN THE PRODUCTION OF FIELD SOLAR CELLS. Final Report. Rolik, P. (Electro-Optical Systems, Inc., Pasadena, Calif.). Dec. 16, 1965. Contract NAS5-9612. 48p. (NASA-CR-75866; EOS-6973-Final). CFSTI $3.00 cy, $0.65 mn.

The results of a study to develop an improved radiation-resistant solar cell by the incorporation of an electric field are described. Included are the results of a theoretical computer evaluation, drift field fabrication experiments, and radiation damage data. The radiation damage data show the results of saturation current, and the diode equation. A factor change as a result of irradiation on a sample group of cells is described. The degradation characteristics of these cells are also given under tungsten and sunlight illumination. (auth)

5110 (NASA-SP-131, pp 239-68) THERMIONICS. Breitwieser, Roland; Schwartz, Herman (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

Basic principles of thermionic conversion are discussed and pertinent characteristics of thermionic converter systems are introduced with reference to space power systems. Primary emphasis is placed on establishing major performance constraints based on fundamental surface and plasma physics, illustrating empirical performance, introducing reactor–converter interface considerations, and reviewing the limitations of two prospective fuels, uranium carbides and uranium dioxides. (F.S.)

5111 (NASA-TM-X-1312) PARAMETRIC ANALYSIS OF RADIOISOTOPE THERMIONIC GENERATORS. Ward, James J.; Blair, Larry S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1966. 30p. CFSTI $3.00 cy, $0.65 mn.

A parametric analysis of a radioisotope-thermionic electric power generator is presented. A cylindrical heat-source geometry was assumed with thermionic diodes located either around the lateral surface of the fuel block or on the flat ends. Generator rather than overall power-system performance was analyzed; that is, such mission-dependent considerations as nuclear shielding, reentry protection, and power conditioning were not included. The heat source was treated parametrically by using the effective-volume power density of the heat source as a variable. Generator efficiency and specific weight were determined for fuel-block length-to-diameter ratios from 0.5 to 10.0, effective-volume power densities from 0.5 to 10.0 watts per cubic centimeter (W/cc), thermionic diode emitter temperatures from 1600 to 2000°K, and generator electrical output powers from 100 to 1000 watts. The results generally indicate that for each configuration a performance advantage is gained by achieving fuel-block effective-volume power densities in the range 3.0 to 5.0 W/cc, a diode emitter temperature of approximately 1800°K, and an electrical output power of about 500 watts. Generator specific weights on the order of 100 pounds per electric kilowatt (lb/kW$_e$) and generator efficiencies greater than 10% were calculated at these operating conditions. (auth)

5112 DISTRIBUTION OF THE CURRENT ON PERMEABLE ELECTRODES IN THE PRESENCE OF HALL EFFECT IN ELECTRIC CONDUCTING FLUX. Emets, Yu. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 35-41(May-June 1966). (In Russian).

Previously published data revealed that due to the Hall effect in an MHD channel the flow distribution of the current on the electrodes was irregular. With Hall parameters of several units, the current flow into an anisotropically conducting medium was coming from a small area at the end of the electrode. An attempt was made to show that by blowing in conducting media it is possible to control the current distribution on the electrodes and keep it more evenly distributed than was indicated in previous work. (R.V.J.)

5113 OPTIMIZATION OF FLOW AND LOAD IN MAGNETOHYDRODYNAMIC GENERATORS. Breev, V. V.; Gubarev, A. V. Teplofiz. Vysok. Temp., 4: 562-71(July-Aug. 1966). (In Russian).

The efficiency of magnetohydrodynamic power transformation was examined. A series of criteria are considered in favor of using MHD generators, and calculations are given of the power output by the installations as units. (tr-auth)

5114 COMPARISON OF VARIOUS TYPES OF MAGNETIC SYSTEMS FOR MAGNETOHYDRODYNAMIC GENERATORS. Bul, B. K.; Bul, O. B. Teplofiz. Vysok. Temp., 4: 572-6(July-Aug. 1966). (In Russian).

Magnetic systems with various coil distributions in magnetohydrodynamic generators were investigated. A magnetic system with coils distributed along the air gap and poles was selected, considering the initial parameters and the weight of the steel. Tabulated data are given for the various parameters calculated for electromagnets. A curve was constructed showing the weight of the magnetic circuit as a function of the maximum field heterogeneity in the channel. (tr-auth)

5115 INVESTIGATION OF CERTAIN CHARACTERISTICS OF p-n JUNCTION PHOTOVOLTAIC ENERGY CONVERTERS PRODUCED BY ION BOMBARDMENT. Gusev, V. M.; Zadde, V. V.; Landsman, A. P.; Titov, V. V. Soviet Phys.-Solid State (Engl. Transl.), 8: 1363-6(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1708-12(June 1966).

The fabrication technique and results of an investigation of some of the characteristics of photovoltaic energy converters produced by bombarding p-type Si with phosphorus ions of ~30-keV energy are described. The minimum irradiation dose which results in the formation of a p-n junction in 4-Ω•cm material and the depth of the junction are determined. After the irradiated crystals were annealed, a p-n junction appeared at a depth of ~1μ with an average donor concentration in the doped layer equal to $\sim 10^{19}/\mathrm{cm}^3$. The maximum efficiency of energy conversion in photovoltaic cells containing p-n junctions of this type lies between 6 and 8%. The photoelectric characteristics of these converters were measured. (auth)

5116 MAGNETOHYDRODYNAMIC GENERATOR. Gebel, Rudolf (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,280,350. Oct. 18, 1966. Priority date Oct. 30, 1963, Germany.

An MHD generator that will utilize to the fullest extent the applied magnetic field for generating a maximum supply of power is discussed. Drawings are included of a longitudinal cross section of the generator, a transverse section, a partly schematic longitudinal cross section of the superconductive coil, and a diagrammatic view showing a manner of winding the coil. (J.H.K.)

5117 OPERATION OF A CESIUM THERMIONIC CONVERTER IN THE PRESENCE OF AN INERT GAS. Bekmukhambetov, E. S.; Guskov, Yu. K.; Kasikov, I. I.; Lebedev, S. Ya.; Stakhanov, I. P.; Rodin, A. V. Zh. Tekh. Fiz., 36: 1481-8(Aug. 1966). (In Russian).

The effect was investigated of the presence of Ne, Ar, Kr, and Xe on the operation of a cesium arc in the 0.5 to 1.0 mm gap between a hot molybdenum foil cathode and a niobium anode. The apparatus was sealed off at 10^{-7} mm Hg after having been cleansed by the usual vacuum techniques. The cesium pressure was controlled by varying the temperature of a branch tube containing metallic cesium, the temperature of the remainder of the apparatus being kept 30 to 50°C higher. The inert gas was admitted in successive doses by breaking tubes containing it. The cesium pressure was varied from 0.0275 to 3.9 mm Hg, and inert gas pressures up to 234 mm Hg were investigated. Very small additions of inert gas increased the plateau of the current-voltage characteristic by some 0.1 V, but further increase of the inert gas pressure led to deterioration of the characteristics of the converter. The presence of the inert gas decreased the saturation current. The saturation current under different conditions was calculated and the results are compared with the measured values. The measured saturation currents were usually from 2 to 10 times lower than the calculated currents. This is ascribed to increase of the inert gas concentration in the hot region between the electrodes as a result of thermal diffusion of the inert gas cesium mixture. Zenon reduced the saturation current less than did neon or krypton; this is ascribed to the fact that the atomic mass of xenon is closer than that of neon or krypton to the atomic mass of cesium. A formula is derived for the thermal diffusion ratio, and with the aid of this formula and the assumption that the observed deviations from the Moyzhes-Pikus theory are due to thermal diffusion, values of the Kr–Cs and Xe–Cs cross sections were calculated from the experimental data. The Kr–Cs and Xe–Cs cross sections were thus found to be 8×10^{-14} and 1.05×10^{-13} cm^2, respectively. (ATD)

5118 INFLUENCE OF LENGTH OF INTERELECTRODE GAP ON OPERATION OF A CESIUM THERMIONIC CONVERTER. Volkov, N. V.; Guskov, Yu. K.; Zyukov, V. I.; Pashchenko, V. P. Zh. Tekh. Fiz., 36: 1475-80(Aug. 1966). (In Russian).

The effect of the interelectrode gap length on the behavior of cesium vapor discharges between an electron beam heated molybdenum cathode and an air cooled stainless steel anode was investigated. Both electrodes were 12 mm in diameter, and the gap between them was varied 0.2 to 8 mm. The cesium vapor pressure was varied at least over the range from 0.2 to 2.0 mm Hg. Meters and an oscilloscope were employed to record the discharge currents and voltages. The shape of the current-voltage characteristic practically did not change with change of gap length and in the undercompensated regime the pressure for maximum power was virtually the same as that for maximum current. Considerable increase of the power output in the undercompensated regime can be obtained by increasing the pressure and decreasing the gap length so as to keep the latter approximately equal to the electron mean free path. In the arc regime the short circuit current was maximum for a certain gap length and decreased almost linearly with increase of the gap beyond the optimum value until the arc was quenched. Considerable hysteresis in the quenching and ignition gap lengths was observed. In the arc regime the power was maximum for a gap length between 5 and 25 times the electron mean free path and decreased with decrease of the gap below this value. When increasing the cesium pressure in order to increase the power output in the arc regime, one should decrease the gap length so as to keep the ratio of the gap length to the electron mean free path approximately constant. (ATD)

Fluid Physics

5119 (AD-637724) THE ONE-DIMENSIONAL UNSTEADY DIFFERENTIAL EQUATION OF THE MGD POTENTIAL FLOW AS A VARIATIONAL PROBLEM. Herrnegger, Franz (Innsbruk Univ. (Austria). Institut fuer Theoretische Physik). Mar. 10, 1966. Contract AF 61(052)-675. 13p. (AFOSR-66-1752). CFSTI $3.00 cy, $0.65 mn.

A method is given for determining an approximate closed solution of a certain nonlinear second-order differential equation. The method is suited for treating nonlinear (propagation of a finite pressure jump) and nonseparable problems. A variational functional to the one-dimensional unsteady potential equation of the ideal MGD (magneto gas dynamics) was given for general values of μ, as a function of the local velocity of sound. This functional was expressed as a function of the velocity potential ϕ for the μ values 3/2 and 2. The variation-integral was evaluated numerically by means of the Ritz method. A modified Kantorovitsch method can be applied in order to obtain higher accuracy since this method allows to determine a continuous function instead of discrete constants $c_{\mu\nu}$: The numerical labor is rather less with this method. There are, however, no results on this method. (auth)

5120 (IAE-1103) O FIZICHESKOI INTERPRETATSII MAGNITOGIDRODINAMICHESKOGO OPISANIYA PLAZMY. (The Physical Interpretation of the Magnetohydrodynamic Description of Plasma). Frank-Kamenetskii, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 20p. (In Russian). Dep. mn.

The physical problems connected with the magnetodynamic description of plasma, and the development of a physically justifiable approximation are discussed. Following a brief outline of the single- and multiple-component formulation of plasma hydrodynamics, theoretical discussions are presented on the freedom in coordinate system selection, stationary three-component magneto-

tice atoms is shown to be recoverable from the single-phonon scattering cross section, which recent advances in the measurement of small energy losses have made experimentally accessible. (auth)

5091 PARAMAGNETIC RESONANCE OF FREE SILVER ATOMS STABILIZED ON SOLID SURFACES. Zhitnikov, R. A.; Paugurt, A. P. (Ioffe Inst. of Physics and Tech., Leningrad. Kalinin Polytechnical Inst., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 1429-35(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1796-1806(June 1966).

X-ray irradiation at 77°K of silica gels, on whose surfaces silver ions were adsorbed, was used to obtain free silver atoms stabilized on these solid surfaces. The stabilized atoms were investigated by the paramagnetic-resonance method. The mechanism of the formation of silver atoms stabilized on a surface is discussed, and the nature of their interaction with the surface is considered. (auth)

5092 CORRELATION BETWEEN OPTICAL AND RADIO EMISSION FROM EXTENSIVE AIR SHOWERS AT LARGE ZENITH ANGLES. McBreen, B.; O'Mongain, E. P.; Porter, N. A.; Slevin, P. J. (University Coll., Dublin). Phys. Lett., 23: 677-8(Dec. 12, 1966).

Evidence was found for correlation between optical and radio emission from extensive air showers at large zenith angles, using a Cherenkov optical detector and wide-band radio system. (auth)

Cosmic Radiation

Refer also to abstracts 4706 and 5164.

5093 (INSJ-100) SPARK CHAMBER PICTURES OF AIR SHOWERS. Akiyama, H.; Ishikawa, F.; Matano, T.; Nagano, M.; Shibata, S.; Suga, K.; Takano, M.; Uchino, K. (Institute of Nuclear Study, Tokyo Univ. (Japan)). Sept. 19, 1966. 24p. Dep. mn.

The spark chamber and EAS array used to study the structure of EAS cores since April 1965 are described. Single cores, multiple cores, and inclined air showers probably produced by muons are discussed briefly, and typical pictures are shown. (A.G.W.)

5094 (N-66-30336) PROPAGATION OF COSMIC RAY NUCLEI IN COSMIC RAY SOURCES, INTERSTELLAR SPACE AND SOLAR SYSTEM. Durgaprasad, N. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1966. 32p. (NASA-TM-X-55513; X-611-66-114). CFSTI $3.00 cy, $0.65 mn.

Simultaneous intensity measurements of protons, helium, and heavy nuclei can be used to describe the effects on the source energy spectrum of solar modulation and diffusion occurring in source regions and in interstellar space. The energy spectra of heavy nuclei ($Z \geq 10$) were determined in the energy region 200 to 700 MeV/nucleon for the year 1961 and compared with similar data obtained for protons, α particles, and heavy nuclei during the years 1961 and 1963. The results indicated that the observed intensities could be adequately explained by the following: (a) the modulating mechanism as described by a model given by Parker compared with the electric deceleration model of modulation, (b) a source differential rigidity or total energy spectrum rather than a kinetic energy spectrum having an exponent of 2.35 (as derived from experimental data available in the high-energy range 10^{10} to 10^{14} eV/nucleon, that is little affected by solar modulation) and (c) a path length of interstellar matter traversed that is decreasing or constant with decreasing energy for energies $\lesssim$ 15 GeV/nucleon. (auth)

5095 EXPERIMENTAL EVALUATION OF VARIOUS RIGIDITY MODELS. Kenney, J. F. (Boeing Co., Seattle); Gauger, J.; Shea, M. A.; Smart, D. F. J. Geophys. Res., 71: 5635-42(Dec. 1, 1966).

Atmospheric cosmic-ray fluxes were measured over large portions of the globe on a series of flights of a United States Air Force jet aircraft. The measured fluxes were plotted as a function of the vertical cutoff rigidity for several different models. The rigorous trajectory calculations of Shea et al., give good agreement with the counting rates. The Makino model also orders these data equally well and therefore must be within a few per cent of the value determined by rigorous orbit calculations taken over the portions of the globe covered in this survey. The other models are demonstrably worse, and a discussion of where these models are inadequate is given. Particular attention is paid to the use of the L parameter as a substitute for rigorous integration procedures. It is shown both experimentally and theoretically that the L parameter is not a good demographic parameter for galactic cosmic radiation at the lower latitudes, but it should be sufficiently accurate at higher latitudes for most purposes. (auth)

5096 THE ENERGY SPECTRUM OF COSMIC-RAY HEAVY NUCLEI OF CHARGE $Z \geq 10$ DURING A SOLAR QUIET TIME IN JULY 1961. Durgaprasad, N. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 71: 5625-33(Dec. 1, 1966).

The energy spectrum of heavy nuclei (charge $Z \geq 10$) was determined, in the energy interval from 200 to 700 MeV/nucleon, using a stack of nuclear emulsions, exposed on July 8, 1961, at a mean altitude of ~2.4 g/cm^2 of residual atmospheric depth on a balloon flown from Fort Churchill, Manitoba. The flight was preceded by a period of three months of low solar and geophysical activity. The charge and energy spectra were obtained principally from tracks of particles that ended in the detector by a combination of range and δ-ray density measurements. A second charge estimation for particles that stop in the emulsion was made from integral δ-ray counts as a function of range. The energy spectrum was measured up to 700 MeV/nucleon by also taking into consideration the tracks that pass through or interact within the stack using a combination of δ-ray density and multiple scattering measurements that determine the charge and energy of the nuclei. This energy spectrum was combined with the spectra measured for protons and helium nuclei in the same flight and with similar data obtained during 1963 with a view of arriving at a better understanding on the propagation of cosmic-ray nuclei in source regions, interstellar space, and the solar system. (auth)

5097 OBSERVATIONS OF THE ISOTROPIC COMPONENT OF COSMIC X RAYS AT BALLOON ALTITUDE. Hudson, H. S.; Primbsch, J. H.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res., 71: 5665-8(Dec. 1, 1966).

The isotropic component of cosmic X-ray flux between 20 and 70 keV was determined from measurements made with balloon-borne X-ray telescopes. In this energy range the spectrum is characterized by $\gamma = 2.7^{+1.7}_{-0.6}$ in the distribution $N(h\nu) = k(h\nu)^{-\gamma}$. The measured flux at 40 keV was $0.014^{+0.008}_{-0.003}$ photons (cm^2 sec sterad kev)$^{-1}$. The observations by Ghielmetti, Becerra, Godel, Heredia, and Roederer of an X-ray influx over the South Atlantic geomagnetic anomaly can probably be explained by the cosmic primary X rays. (auth)

5098 SOME OBSERVATIONS OF THE COSMIC-RAY EVENT OF APRIL 18, 1965. Houston, Robert E.; Earhart, J. Ronald (Univ. of New Hampshire, Durham). J. Geophys. Res., 71: 5762-4 (Dec. 1, 1966).

On April 18, 1965, the 22-MHz riometer located at Durham, New Hampshire, indicated an unusual disturbance. Tracings of some of the records of this event are shown. Station riometer data available for the period 0500 to 1000 on April 18, 1965, are listed. Plots of average counts per hour in a 24-hour day versus day of the month for cosmic-ray data obtained from neutron monitors located at seven stations around the earth are shown. Also, the time sequence of the horizontal component of the earth's magnetic field for the magnetometer located at Fredericksburg, Virginia, is included. (J.H.M.)

5099 COSMIC-RAY ELECTRON LIFETIMES IN THE GALACTIC DISK AND HALO. Ramaty, Reuven; Lingenfelter, Richard E. (Univ. of California, Los Angeles). Phys. Rev. Lett., 17: 1230-2 (Dec. 12, 1966).

Recent measurements of cosmic-ray electrons of 12 to 350 BeV, indicate that their differential energy spectrum can be fitted by a power law with spectral index of 2.1 ± 0.2. This index is the same as that found at energies of a few BeV, which seems to contradict the expected steepening of the spectrum because of synchrotron and inverse Compton losses. As a result of this discrepancy, Daniel and Stephens (Phys. Rev. Letters, 17: 935(1966)) concluded that either the 3°K black-body radiation does not exist or there is an additional high-energy source of electrons with spectral index of 1.1. It is proposed instead that the observed high-energy electron spectrum results from a cosmic-ray mean lifetime in the galactic disk that is shorter than the lifetime against radiation losses by these electrons, but long enough to establish a measurable equilibrium flux. (W.D.M.)

5100 DETERMINATION OF THE FLUX OF PRIMARY COSMIC RAY HYDROGEN AND HELIUM NUCLEI NEAR THE GEOMAGNETIC EQUATOR USING NUCLEAR EMULSIONS. PART II. FLUX OF HELIUM NUCLEI ON MARCH 24, 1960 AT GEOMAGNETIC LATITUDE 7.6 DEG N. Kajarekar, P. J. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 64: 123-7(Sept. 1966).

The flux of helium nuclei of the primary cosmic radiation at the top of the atmosphere was determined over Hyderabad, India, at a time of high solar activity in the 11-year cycle, namely March 24, 1960. The flux value was found to be 17.9 ± 1.9 helium nuclei per m^2 sec sterad corresponding to a vertical geomagnetic cut off energy of 7.5 GeV/nucleon. This result when compared with other observations made near the geomagnetic equator shows that the solar modulation effects, if any, at rigidities >16 GV should be $\lesssim$10% only. (auth)

5101 ROLE OF THE GEOMETRY OF THE SOLAR SYSTEM IN GROUND OBSERVATIONS OF COSMIC-RAY VARIATIONS. Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 181-8 (1966).

Translated from Geomagn. Aeronomiya, 6: 231-40(1966).

It is shown that allowance for the mutual position of the earth and sun and of their axes of rotation makes it possible to obtain additional information on the angular distribution and transverse gradient of cosmic-ray intensity in interplanetary space. Geometric effects leading to the modulation of solar-diurnal and stellar-diurnal variations, and the appearance of annual and semi-annual cosmic-ray variations are examined. (auth)

5102 ISOTROPIZATION OF COSMIC RAYS. Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Soviet Astron.-AJ (Engl. Transl.), 10: 419-28(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 528-42(May-June 1966).

The role of plasma effects in isotropizing cosmic rays is discussed. Two isotropization mechanisms are considered: cosmic-ray beam instability, and scattering of cosmic rays by turbulent plasma pulsations. The conditions necessary for isotropization by beam instability are described. In the initial development of beam instability very large increments arise, which would isotropize cosmic rays in a relatively short time if not prevented by nonlinear interaction effects between the oscillations generated. For relativistic cosmic-ray particles nonlinear effects will, in cases of practical interest, tend to eliminate the instability and arrest the isotropization at very low values for the energy transferred by cosmic rays to plasma oscillations. This process will occur if the plasma ions have a nearly Maxwellian equilibrium distribution. However, if ion beams occur with mean velocities close to the thermal-ion velocity and densities close to the thermal-ion density, the nonlinear effects will facilitate isotropization. Analysis shows that the problem of isotropization by beam instability is closely related to the problem of ion motion, which is often controlled by gravitational forces. Isotropization may therefore be promoted by galactic rotation, gravitational instability, the plasma inhomogeneities that often occur in supernova envelopes and other objects (ion drifts arise in plasma inhomogeneities). Cosmic-ray isotropization through scattering by turbulent plasma pulsations is highly efficient. The treatment of this mechanism assumes that the turbulent pulsations are excited by sources other than cosmic rays. Isotropization effects resulting from scattering of cosmic rays by high-frequency turbulent pulsations and by hydrodynamic pulsations are considered. The relative contribution of hydrodynamic and high-frequency plasma turbulence is estimated. It is important to note that these isotropization mechanisms do not necessarily entail magnetic fields, and particularly that they are local mechanisms. (auth)

5103 PRIMARY COSMIC-RAY SPECTRUM AT HIGH ENERGIES AND SPECTRA OF γ RAYS AND MUONS IN THE ATMOSPHERE. Pal, Yash; Tandon, S. N. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 151: 1071-5(Nov. 25, 1966).

The shape of the primary cosmic-ray spectrum at very high energies and its connection with the spectra of high-energy γ-rays and muons in the atmosphere are discussed. Using a simple formulation for calculating secondary spectra arising from power-law primary spectra cutoff at arbitrary points, it is shown that a specific two-component model for the primary spectrum explains the present observations on the high-energy γ-ray spectrum at all altitudes and the muon spectrum at sea level, without invoking any change in the character of the interactions at high energies. Such a spectrum is also consistent with air-shower observations. (auth)

5104 ASTRONOMY OF THE NEUTRINO. Masani, A. (Osservatorio Astronomico di Brera, Milan); Gallino, R.; Silvestro, G. Nuovo Cimento (1), 3: Suppl., 934-1028(1965). (In Italian).

The most significant developments in the field of neutrino astronomy are summarized. The production of low-energy neutrinos at the interior of stars, the detectability of low-energy neutrinos, and high-energy neutrinos produced by cosmic radiation are considered. (J.S.R.)

5105 COMPARISON OF SPECTRAL CHARACTERISTICS OF LONG-TERM AND SHORT-TERM CHANGES IN COSMIC-RAY INTENSITY. Kane, R. P. (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 45B: 132-7(Oct. 11, 1966).

Spectral characteristics of the long-term change of cosmic-ray intensity in the period 1963–65 are compared with that of the Forbush decrease which occurred in September 1963. For a spectrum of type E^{-m}, the long-term change has an exponent m of about 1.1 for 1963 increasing to about 1.5 by 1964 end. In contrast, the Sept. 1963 Forbush decrease has m about 0.7 indicating a much flatter energy-dependence. (auth)

5106 IONIZATION OF THE LOWER IONOSPHERE BY COSMIC RAYS. Velinov, P. (Inst. of Geophysics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 281-4 (1966). (In Russian).

The formula for electron production by cosmic rays was expanded for the lower-energy cosmic rays which are produced at geomagnetic latitude larger than $\lambda_m \approx 55°$. (R.V.J.)

Direct Energy Conversion

5107 (AECL-Pak-Lib/15) SOLAR ENERGY. A Bibliography of Selected Literature. Rafique, M. M.; Afzal, F. A.; Saleem, M. (Atomic Energy Centre, Lahore (Pakistan)). Sept. 1966. 79p. Dep. mn.

A total of 907 references to unclassified reports and the published literature is presented on the subject of solar energy. (auth)

5108 (JPL-TR-32-981) JPL FISSION-ELECTRIC CELL EXPERIMENT. Krieve, W. F. (Jet Propulsion Lab., Pasadena, Calif.). Nov. 15, 1966. Contract NAS 7-100. 20p.

A series of experiments was performed with two different large concentric cylinder fission–electric cells in thermal neutron fluxes up to 10^{10} n/cm^2 sec at the General Electric Nuclear Test Reactor. A clearcut demonstration of the fission–electric cell concept was achieved. Fission fragment currents up to 10^{-8} A, which were in good agreement with calculated values, were observed. Magnetic field suppression of electron countercurrents was completely successful. Electrostatic grid suppression of the extraneous electrons was much less effective. The original cell configuration, in which the anode cylinder surrounded the inner cathode cylinder, achieved stable potentials of approximately one kV. The modified configuration, in which the cathode with electron sweep rings surrounded the anode, reached potentials as great as 21 kV, but was not stable above 4 kV. (auth)

5109 (N-66-29520) ADVANCEMENT IN THE STATE OF THE ART IN THE PRODUCTION OF FIELD SOLAR CELLS. Final Report. Rolik, P. (Electro-Optical Systems, Inc., Pasadena, Calif.). Dec. 16, 1965. Contract NAS5-9612. 48p. (NASA-CR-75866; EOS-6973-Final). CFSTI $3.00 cy, $0.65 mn.

The results of a study to develop an improved radiation-resistant solar cell by the incorporation of an electric field are described. Included are the results of a theoretical computer evaluation, drift field fabrication experiments, and radiation damage data. The radiation damage data show the results of saturation current, and the diode equation. A factor change as a result of irradiation on a sample group of cells is described. The degradation characteristics of these cells are also given under tungsten and sunlight illumination. (auth)

5110 (NASA-SP-131, pp 239-68) THERMIONICS. Breitwieser, Roland; Schwartz, Herman (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

Basic principles of thermionic conversion are discussed and pertinent characteristics of thermionic converter systems are introduced with reference to space power systems. Primary emphasis is placed on establishing major performance constraints based on fundamental surface and plasma physics, illustrating empirical performance, introducing reactor–converter interface considerations, and reviewing the limitations of two prospective fuels, uranium carbides and uranium dioxides. (F.S.)

5111 (NASA-TM-X-1312) PARAMETRIC ANALYSIS OF RADIOISOTOPE THERMIONIC GENERATORS. Ward, James J.; Blair, Larry S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1966. 30p. CFSTI $3.00 cy, $0.65 mn.

A parametric analysis of a radioisotope-thermionic electric power generator is presented. A cylindrical heat-source geometry was assumed with thermionic diodes located either around the lateral surface of the fuel block or on the flat ends. Generator rather than overall power-system performance was analyzed; that is, such mission-dependent considerations as nuclear shielding, reentry protection, and power conditioning were not included. The heat source was treated parametrically by using the effective-volume power density of the heat source as a variable. Generator efficiency and specific weight were determined for fuel-block length-to-diameter ratios from 0.5 to 10.0, effective-volume power densities from 0.5 to 10.0 watts per cubic centimeter (W/cc), thermionic diode emitter temperatures from 1600 to 2000°K, and generator electrical output powers from 100 to 1000 watts. The results generally indicate that for each configuration a performance advantage is gained by achieving fuel-block effective-volume power densities in the range 3.0 to 5.0 W/cc, a diode emitter temperature of approximately 1800°K, and an electrical output power of about 500 watts. Generator specific weights on the order of 100 pounds per electric kilowatt (lb/kW_e) and generator efficiencies greater than 10% were calculated at these operating conditions. (auth)

5112 DISTRIBUTION OF THE CURRENT ON PERMEABLE ELECTRODES IN THE PRESENCE OF HALL EFFECT IN ELECTRIC CONDUCTING FLUX. Emets, Yu. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 35-41(May-June 1966). (In Russian).

Previously published data revealed that due to the Hall effect in an MHD channel the flow distribution of the current on the electrodes was irregular. With Hall parameters of several units, the current flow into an anisotropically conducting medium was coming from a small area at the end of the electrode. An attempt was made to show that by blowing in conducting media it is possible to control the current distribution on the electrodes and keep it more evenly distributed than was indicated in previous work. (R.V.J.)

5113 OPTIMIZATION OF FLOW AND LOAD IN MAGNETOHYDRODYNAMIC GENERATORS. Breev, V. V.; Gubarev, A. V. Teplofiz. Vysok. Temp., 4: 562-71(July-Aug. 1966). (In Russian).

The efficiency of magnetohydrodynamic power transformation was examined. A series of criteria are considered in favor of using MHD generators, and calculations are given of the power output by the installations as units. (tr-auth)

5114 COMPARISON OF VARIOUS TYPES OF MAGNETIC SYSTEMS FOR MAGNETOHYDRODYNAMIC GENERATORS. Bul, B. K.; Bul, O. B. Teplofiz. Vysok. Temp., 4: 572-6(July-Aug. 1966). (In Russian).

Magnetic systems with various coil distributions in magnetohydrodynamic generators were investigated. A magnetic system with coils distributed along the air gap and poles was selected, considering the initial parameters and the weight of the steel. Tabulated data are given for the various parameters calculated for electromagnets. A curve was constructed showing the weight of the magnetic circuit as a function of the maximum field heterogeneity in the channel. (tr-auth)

5115 INVESTIGATION OF CERTAIN CHARACTERISTICS OF p-n JUNCTION PHOTOVOLTAIC ENERGY CONVERTERS PRODUCED BY ION BOMBARDMENT. Gusev, V. M.; Zadde, V. V.; Landsman, A. P.; Titov, V. V. Soviet Phys.-Solid State (Engl. Transl.), 8: 1363-6(Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1708-12(June 1966).

The fabrication technique and results of an investigation of some of the characteristics of photovoltaic energy converters produced by bombarding p-type Si with phosphorus ions of ~30-keV energy are described. The minimum irradiation dose which results in the formation of a p-n junction in 4-Ω·cm material and the depth of the junction are determined. After the irradiated crystals were annealed, a p-n junction appeared at a depth of ~1μ with an average donor concentration in the doped layer equal to $\sim 10^{19}/cm^3$. The maximum efficiency of energy conversion in photovoltaic cells containing p-n junctions of this type lies between 6 and 8%. The photoelectric characteristics of these converters were measured. (auth)

5116 MAGNETOHYDRODYNAMIC GENERATOR. Gebel, Rudolf (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,280,350. Oct. 18, 1966. Priority date Oct. 30, 1963, Germany.

An MHD generator that will utilize to the fullest extent the applied magnetic field for generating a maximum supply of power is discussed. Drawings are included of a longitudinal cross section of the generator, a transverse section, a partly schematic longitudinal cross section of the superconductive coil, and a diagrammatic view showing a manner of winding the coil. (J.H.K.)

5117 OPERATION OF A CESIUM THERMIONIC CONVERTER IN THE PRESENCE OF AN INERT GAS. Bekmukhambetov, E. S.; Guskov, Yu. K.; Kasikov, I. I.; Lebedev, S. Ya.; Stakhanov, I. P.; Rodin, A. V. Zh. Tekh. Fiz., 36: 1481-8(Aug. 1966). (In Russian).

The effect was investigated of the presence of Ne, Ar, Kr, and Xe on the operation of a cesium arc in the 0.5 to 1.0 mm gap between a hot molybdenum foil cathode and a niobium anode. The apparatus was sealed off at 10^{-7} mm Hg after having been cleansed by the usual vacuum techniques. The cesium pressure was controlled by varying the temperature of a branch tube containing metallic cesium, the temperature of the remainder of the apparatus being kept 30 to 50°C higher. The inert gas was admitted in successive doses by breaking tubes containing it. The cesium pressure was varied from 0.0275 to 3.9 mm Hg, and inert gas pressures up to 234 mm Hg were investigated. Very small additions of inert gas increased the plateau of the current-voltage characteristic by some 0.1 V, but further increase of the inert gas pressure led to deterioration of the characteristics of the converter. The presence of the inert gas decreased the saturation current. The saturation current under different conditions was calculated and the results are compared with the measured values. The measured saturation currents were usually from 2 to 10 times lower than the calculated currents. This is ascribed to increase of the inert gas concentration in the hot region between the electrodes as a result of thermal diffusion of the inert gas cesium mixture. Zenon reduced the saturation current less than did neon or krypton; this is ascribed to the fact that the atomic mass of xenon is closer than that of neon or krypton to the atomic mass of cesium. A formula is derived for the thermal diffusion ratio, and with the aid of this formula and the assumption that the observed deviations from the Moyzhes-Pikus theory are due to thermal diffusion, values of the Kr–Cs and Xe–Cs cross sections were calculated from the experimental data. The Kr–Cs and Xe–Cs cross sections were thus found to be 8×10^{-14} and 1.05×10^{-13} cm^2, respectively. (ATD)

5118 INFLUENCE OF LENGTH OF INTERELECTRODE GAP ON OPERATION OF A CESIUM THERMIONIC CONVERTER. Volkov, N. V.; Guskov, Yu. K.; Zyukov, V. I.; Pashchenko, V. P. Zh. Tekh. Fiz., 36: 1475-80(Aug. 1966). (In Russian).

The effect of the interelectrode gap length on the behavior of cesium vapor discharges between an electron beam heated molybdenum cathode and an air cooled stainless steel anode was investigated. Both electrodes were 12 mm in diameter, and the gap between them was varied 0.2 to 8 mm. The cesium vapor pressure was varied at least over the range from 0.2 to 2.0 mm Hg. Meters and an oscilloscope were employed to record the discharge currents and voltages. The shape of the current-voltage characteristic practically did not change with change of gap length and in the undercompensated regime the pressure for maximum power was virtually the same as that for maximum current. Considerable increase of the power output in the undercompensated regime can be obtained by increasing the pressure and decreasing the gap length so as to keep the latter approximately equal to the electron mean free path. In the arc regime the short circuit current was maximum for a certain gap length and decreased almost linearly with increase of the gap beyond the optimum value until the arc was quenched. Considerable hysteresis in the quenching and ignition gap lengths was observed. In the arc regime the power was maximum for a gap length between 5 and 25 times the electron mean free path and decreased with decrease of the gap below this value. When increasing the cesium pressure in order to increase the power output in the arc regime, one should decrease the gap length so as to keep the ratio of the gap length to the electron mean free path approximately constant. (ATD)

Fluid Physics

5119 (AD-637724) THE ONE-DIMENSIONAL UNSTEADY DIFFERENTIAL EQUATION OF THE MGD POTENTIAL FLOW AS A VARIATIONAL PROBLEM. Herrnegger, Franz (Innsbruk Univ. (Austria). Institut fuer Theoretische Physik). Mar. 10, 1966. Contract AF 61(052)-675. 13p. (AFOSR-66-1752). CFSTI $3.00 cy, $0.65 mn.

A method is given for determining an approximate closed solution of a certain nonlinear second-order differential equation. The method is suited for treating nonlinear (propagation of a finite pressure jump) and nonseparable problems. A variational functional to the one-dimensional unsteady potential equation of the ideal MGD (magneto gas dynamics) was given for general values of μ, as a function of the local velocity of sound. This functional was expressed as a function of the velocity potential ϕ for the μ values 3/2 and 2. The variation-integral was evaluated numerically by means of the Ritz method. A modified Kantorovitsch method can be applied in order to obtain higher accuracy since this method allows to determine a continuous function instead of discrete constants $c_{\mu\nu}$: The numerical labor is rather less with this method. There are, however, no results on this method. (auth)

5120 (IAE-1103) O FIZICHESKOI INTERPRETATSII MAGNITOGIDRODINAMICHESKOGO OPISANIYA PLAZMY. (The Physical Interpretation of the Magnetohydrodynamic Description of Plasma). Frank-Kamenetskii, D. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 20p. (In Russian). Dep. mn.

The physical problems connected with the magnetodynamic description of plasma, and the development of a physically justifiable approximation are discussed. Following a brief outline of the single- and multiple-component formulation of plasma hydrodynamics, theoretical discussions are presented on the freedom in coordinate system selection, stationary three-component magnetohydrodynamics, nonstationary multiple-component magnetohydrodynamics, the uniform acceleration approximation, the fictitious forces, and the thermal forces and thermal diffusion. The newly developed approach permits the incorporation of all the forms of drift motion and transport processes. The general structure of the resulting equations agrees with the kinetic theory approximations. In the simple limiting cases (dissipation without collisions) the system of multiple-component magnetohydrodynamics is in fully satisfactory agreement with the results of more complicated kinetic calculations. (JPRS)

5121 (ORNL-P-2724) MAGNETOHYDRODYNAMIC STABILIZATION EXPERIMENTS WITH JET-DRIVEN VORTEX FLOWS. Keyes, J. J. Jr. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 8p. (CONF-661111-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting, American Physical Society, Fluid Dynamics Division, Stanford, Calif.

A review is presented on some experiments in which a study was made of the influence of intense axial magnetic fields on jet-driven vortex flow of an electrolytic conductor. The results of flow visualization studies are emphasized. (J.H.M.)

5122 EFFECT OF A MAGNETIC FIELD ON THE STAGNATION-POINT FLOW PAST A BLUNT BODY IN THE PRESENCE OF ABLATION OF AN ELECTRICALLY CONDUCTING SHIELD. Tropp, E. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 17-25(May-June 1966). (In Russian).

This analytical study of the effect of a magnetic field on stagnation-point flow in the presence of ablation is an extension of a previous work by Tirskii (1965) on the domain of magnetogasdynamics. The two- and three-dimensional hypersonic axisymmetrical flows of a mixture of chemically reacting viscous gases and vapors of a subliming material past a blunt body are considered under the effect of a homogeneous magnetic field normal to the body surface. It is assumed that the external electric field is absent, the gas behind the shock wave is sufficiently dense, the applied magnetic field is weak, and the electrical conductivity of both the gas and vapors is constant. Thus, the effect of the induced magnetic field is neglected. The boundary layer equations differ from those of gasdynamics by the term which accounts for a ponderomotive force in the equation of motion. A system of nondimensional equations of a steady self-similar flow regime in the stagnation-point region is derived. The analysis includes the equations of the boundary layer in the gas, and in the molten material, and the equations of thermal conductivity in a solid body with boundary conditions on the outer edge of the boundary layer, on the interface of a gas and a molten material, on the interface of a molten material and a solid body, and inside a solid body. Electrically nonconducting and electrically conducting gas flows were considered. The results of calculations made for various values of the magnetic parameter $\xi = 0, 0.6, 0.8, 1.0, 1.5$, and presented in graphs show that: (1) the shear stress and heat transfer decrease with increase in the magnetic field, (2) the interaction of a magnetic field with an electrically conducting gas leads to decrease in the melting rate and thickening of the molten layer, and (3) the effect of the magnetic field is more evident in the presence of evaporation. (ATD)

5123 QUALITATIVE EQUATIONS OF A QUASI-ONE DIMENSIONAL MAGNETOHYDRODYNAMIC FLOW IN CHANNELS. Slobodkina, F. A. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 26-34(May-June 1966). (In Russian).

Qualitative studies of a differential equation system describing quasi-one-dimensional stable flow of an electric-conducting medium at small magnetic Reynolds number indicate the possible flow conditions at various electromagnetic field and channel configurations. Previously, studies were made of the flow in a homogeneous electromagnetic field in a constant cross-sectional channel, at given magnetic field dependence of the rate of the flow which was resolved by analysis of integral curves in a plane. An attempt was made at resolving an arbitrary distribution of electric and magnetic fields and channel configurations by means of integral curves in a space. Qualitative results are illustrated by various examples. (tr-auth)

5124 THEORY OF MAGNETOGASODYNAMIC FLOW. Kolosnitsyn, N. I. (All-Union Inst. of Electromechanics, USSR). Teplofiz. Vysok. Temp., 4: 524-30(July-Aug. 1966). (In Russian).

An integration method was previously developed for quasi-one-dimensional approximation of magnetogasdynamic equations, considering the finite conductivity and magnetic fields. Here the method is simplified, its limitations are established, and the initial quadrature for the main types of flow is found. (tr-auth)

5125 FLUID FLOW IN A UNIFORM MAGNETIC FIELD IN THE INDUCTIVE PIPE. Ihara, Sadatoshi (Waseda Univ., Tokyo); Matsushima, Akira. Nippon Kikai Gakkai Rombunshu, 31: 1680-8(Nov. 1965). (In Japanese).

Flow of an inductive fluid across a uniform magnetic field in the inductive pipe was studied. The pipes used were of SUS-27, carbon, and glass, and mercury was used as the fluid. A strict analytic equation was calculated for the magnetic flow in the pipes, and with this equation, the relation between Poiseuille's and Hartmann's figures was studied. It was found that the result obtained corresponded to Tanazawa's and Gold's results extended to the case of the inductive pipes. The case of the peculiar parameters was compared with the Shercliff, Tanazawa, and Gold results and showed good agreement. An approximate equation for this peculiar case was obtained; for example, a strict equation for the voltage between two points on the inductive pipe laid at right angles to the magnetic field and to the flow. This equation may play an important roll in the measurement of the magnetic flow and in others. As regards the relation between the Poiseuille's and Hartmann's figures, the experimental results agreed well with the theoretical. (NSA of Japan)

5126 MOTION OF A CONDUCTING SYMMETRIC TOP IN MAGNETIC FIELD. Kuznetsov, E. N. Izv. Akad. Nauk SSSR, Mekh., No. 4, 124-5(1965). (In Russian).

The motion of a symmetric conducting top in an external magnetic field was studied analytically. The motion of the top in the magnetic field is shown to generate eddy currents which in turn give rise to magnetic moments that interact with the external magnetic field and create mechanical moments that affect the motion of the top. A nonlinear differential equation of motion is developed, which is solved by the Poincaré method using a perturbation expansion in $\mu = 2kVH^2/A \ll 1$. The solution leads to expressions for the angular velocity of precession and spin and a numerical example is given. (ATD)

5127 CONCERNING THE FORMULATION OF PROBLEMS IN THE THEORY OF THE FLOW OF A STRONGLY RAREFIED IONIZED GAS PAST CHARGED BODIES. Shidlovskii, V. P. Rev. Roum. Sci. Tech., Ser. Mec. Appl., 11: 635-41(1966). (In Russian).

A discussion is presented of the flow of a strongly rarefied, fully ionized plasma past an electrically charged body. It is shown that in the absence of a magnetic field, the problem can be reduced to the solution of a system of two kinetic equations (without collision integrals) and the Poisson equation. Linearization of the equations is examined as a possible means of simplifying this system of equations. Another possibility consists in solving the system of equations for a given functional form of the potential. It is shown that, under certain conditions, the second method can provide a fairly accurate description of the physical processes involved. (Inst. Aero. Abstr.)

Geophysics

Refer also to abstract 4794.

5128 (AD-637207) INFLUENCE OF INTERPLANETARY MAGNETIC FIELD AND PLASMA ON GEOMAGNETIC ACTIVITY DURING QUIET-SUN CONDITIONS. Wilcox, John M.; Schatten, Kenneth H.; Ness, Norman F. (California Univ., Berkeley. Space Sciences Lab.). Aug. 2, 1966. Contract Nonr-3656(26). 36p. CFSTI $3.00 cy, $0.65 mn.

Observations by the IMP-1 satellite of the interplanetary magnetic field and plasma were compared with the three-hour geomagnetic activity index K_p. The average K_p is approximately a linear function of the interplanetary field magnitude B in gammas. It appears significant that this relation between average K_p and field magnitude passes through the origin, whereas the linear relation between average K_p and solar wind velocity does not. The average K_p is approximately a linear function of solar wind velocity, but with perhaps a slightly different slope and zero intercept from the similar relation observed by Snyder, Neugebauer, and Rao with Mariner 2. Little correlation is observed between average K_p and solar wind density, but this result is consistent with the interplanetary sector pattern discussed by Wilcox and Ness. Cross correlation as a function of time lag of K_p and interplanetary field (or solar wind velocity) yields a positive peak correlation at zero lag, suggesting that a large part of the response of the magnetosphere to solar wind excitation occurs within the three-hour K_p period. (auth)

5129 (AD-637472) QUASI-TRAPPED VLF PROPAGATION IN THE OUTER MAGNETOSPHERE. Thorne, R. M.; Kennel, C. F. (Avco-Everett Research Lab., Everett, Mass.). June 1966. Contracts NASw-837; AF 49(638)-1483. 43p. (RR-251). CFSTI $3.00 cy, $0.65 mn.

Very-low-frequency radiation has now been detected in various regions of the magnetosphere, and it seems feasible in the near future to undertake experiments correlating the intensity of such radiation at different points along the ray path. The further suggestion that trapped electrons may generate whistler mode waves in equatorial high L regions, has stimulated interest in the propagation of such waves in an unducted magnetosphere. A simplified but not unreasonable density distribution, proportional to magnetic field strength along the equator and constant along field lines, has been used. For frequencies well below the electron cyclotron frequency and propagation vectors not too close to perpendicular to the magnetic field, this leads to an index of refraction relation independent of wave frequency and L. Waves originating at the equator rapidly become almost perpendicular to the field. Rough consideration of propagation in the neighborhood of the lower hybrid resonance suggests that low-frequency waves will be reflected before reaching the ionosphere and thus be quasi-trapped in the magnetosphere. Such waves would not be observed by low-altitude satellites. Waves of sufficiently high frequency should be detectable at low altitudes, but would then have wave vectors predominantly perpendicular to the ambient magnetic field, and thus considerable energy in the oscillating electric field. (auth)

5130 (GA-7419) ELECTRONIC AND IONIC REACTIONS IN ATMOSPHERIC GASES. Yearly Technical Summary Report, September 1, 1965–August 31, 1966. Turner, B. R.; Compton, D. M. J.; McGowan, J. Wm. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 14, 1966. Contract DA-49-146-XZ-354. 82p. (DASA-1863).

The cross sections for charge transfer in collisions between nitric oxide and atomic and molecular positive ions of oxygen and nitrogen were measured in the energy range from 3 to 200 eV in a crossed-beam experiment. A smooth interpolation is made between these results and the rate coefficients obtained at thermal energy by the afterglow technique. The dependence of these cross sections upon the energy of the electrons used to produce the primary ions was also investigated in order to gain insight into the importance of the states of excitation of the primary ions. Using information similar to the above for the reaction $O_2^+ + N_2 \rightarrow O_2 + N_2^+$, a technique to determine the fractional concentration of the excited ions in an ion beam as a function of source electron energy was developed. The determination is made approximately 20 μsec after formation of the ions, so that only long-lived states remain in the beam. Basically, the method consists of attenuating the ion beam in a gas-filled chamber where, in general, the excited ion attenuation is different from the ground-state ion attenuation. The study was completed for the case of an O_2^+ ion beam, and only one excited state appeared to be important. These results and the method are discussed, and the values of the ground-state and excited-state cross sections reported for the $O_2^+ + N_2 \rightarrow O_2 + N_2^+$ reaction. Several negative ion reactions, primarily charge transfer, were investigated in the energy range 2 eV to several hundred eV. Emphasis was placed on reactions leading to NO_2^- production, since the only rocket data available showed NO_2^- to be the dominant negative ion in the E region; this result was also supported by laboratory experience with negative ion sources. The cross sections for charge exchange of neutral NO_2 with O^-, O_2^-, O_3^-, and OH^- were found to be large and to increase as the interaction energy was reduced. Development work on an atomic oxygen source has been carried out, and the results are described. The source is suitable for the measurement of relative cross sections. The dependence of the cross section for the reaction $N_2O + e \rightarrow N_2 + O^-$ on N_2O temperature was measured to be small, unlike that for similar reactions for O_2. The ionization cross section near threshold for O_2 was analyzed, and an interpretation of the ionization cross section is given for O_2, N_2, and H_2 in terms of the relative contributions of direct and indirect ionization processes. (auth)

5131 (N-66-30334) ELECTRONS IN THE VAN ALLEN ZONE MEASURED WITH A SCINTILLATOR ON EXPLORER XIV. Pizzella, G.; Davis, L. R.; Williamson, J. M. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar. 1966. 46p. (NASA-TM-X-55511; X-611-66-112). CFSTI $3.00 cy, $0.65 mn.

The energy spectrum of electrons in the energy range from 5 to 160 keV was investigated near the equator, at L shells between 2 and 10, by using scintillator measurements on Explorer XIV. The following results were obtained: (1) peak values of 8×10^8 electrons/cm^2/sec with an average energy of ~50 keV at L ~ 5; (2) peak values of 1.6×10^9 electrons/cm^2/sec with an average energy of ~10 keV at $L \geq 8$; (3) time variations of intensity by factors of 10 or less above L ~ 4 during the 15 days of data under study; and (4) discontinuity of the energy spectrum at L ~ 7, with a general tendency for the spectrum to become softer at higher L. The 10-keV electrons measured at L ~ 8 are trapped in the earth's field and appear not to be a tail of the outer-belt electrons. These electrons are unable, without an accompanying replenishing mechanism, to supply the auroral regions. (auth)

5132 (N-66-30342) REPORT ON UNITED STATES–NEW ZEALAND SOLAR ECLIPSE PROJECT. Bissell, Edward E. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1966. 119p. (NASA-TM-X-55519; X-721-66-153). CFSTI $3.00 cy, $0.65 mn.

A discussion is presented on the operational aspects of the eclipse project that examines the airborne and ground-based electronic systems, and a brief description is given of the installation and operation of the boosted Arcas rocket system. During the May 1965 total solar eclipse, in a joint United States–New Zealand operation, six boosted Arcas rockets were successfully fired within 120 minutes from a remote location in Northern New Zealand. Five rockets were fired from a single launcher, while the last rocket was held in a ready condition and fired from a second launcher. Each rocket payload comprised a 12-pound miniaturized instrumentation system designed to gather and telemeter lower ionosphere electron and ion density data. Prelaunch and countdown preparations are supplied and sample radiation patterns for a dipole antenna enclosed within a plastic nose cone are included in an appendix. (auth)

5133 (N-66-30747) VIOLATION OF THE SECOND AND THIRD ADIABATIC INVARIANTS BY HYDROMAGNETIC WAVES. Conrath, Barney Jay (New Hampshire Univ., Durham. Dept. of Physics). Oct. 1965. 117p. (NASA-CR-76294). CFSTI $3.00 cy, $0.65 mn.

Thesis.

Violation of the second invariant is investigated, using a simplified model of converging field lines. Expressions for characteristic lifetimes and diffusions have been obtained and numerical examples are given. Violation of the third invariant by large-scale magnetic disturbances with a sinusoidal dependence is investigated, using an image dipole model. Characteristic diffusion times are derived and the formulation is applied to an example of electrons with energies greater than 1.6 MeV at L = 4. The sinusoidal model is also compared with the sudden disturbance models of previous studies. The results of the studies are used to define measurements which could be employed to study the specific mechanisms experimentally. The calculations of this study are primarily intended to be used as tools in the correlation of particle data with magnetic field data. (auth)

5134 (N-66-32251) ELECTRODYNAMICS OF THE MAGNETOSPHERE: GEOMAGNETIC STORMS. Akasofu, Syun-Ichi (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). May 1966. 331p. (NASA-CR-76676). CFSTI $3.00 cy, $0.65 mn.

Geomagnetic and auroral storms provide a great deal of detailed information on the interaction between the solar plasma flows and the magnetosphere. Vast numbers of observations have been accumulated, and many theories have been developed to explain them. However, many of the most vital features of the interaction remain unsolved. A background is provided here for future work by summarizing fundamental morphological data and by reviewing critically the proposed theories. The structure of the solar plasma flows and the magnetosphere are briefly discussed. Effects of the direct impact of the plasma flows on the magnetosphere are described. Also included is a discussion of the major phase of geomagnetic storms, namely the formation of the asymmetric ring current belt and the development of the auroral and polar magnetic substorms, respectively. (auth)

5135 MICROPULSATION "NOSE WHISTLERS." A HELIUM EXPLANATION. Dowden, R. L. (Univ. of Otago, New Zealand). Planet. Space Sci., 14: 1273-80(Dec. 1966).

Occasionally micropulsation dynamic spectra show a series of nosed tones in place of the more usual purely rising tones. These are explained in some detail if, at times, some 3 to 10% of the ionic content in the outer magnetosphere is helium (H_e^+). Although this is one or two orders of magnitude greater than expected from diffusive equilibrium theory, it is in broad agreement with recent Ogo-A measurements. (auth)

5136 OBSERVATIONS ON THE OUTER IONOSPHERE BY THE AID OF SIGNALS FROM EXPLORER 22 (S 66). Schmelovsky, Karl Heinz; Felske, Dieter (Observatorium fuer Ionosphaerenforschung, Ostseebad Kuehlungsborn, Ger.). Beitr. Geophys., 74: 451-66(1965). (In German).

Various methods for investigation of total electron content of the ionosphere by satellite signal observations (dispersive Doppler shift, Faraday fading, and hybrid methods) are discussed, and illustrated by some examples of fading and dispersive Doppler records at 20 and 40 Mc. The results of dispersive Doppler investigations in November 1964 show regular diurnal variations of total electron content at about 54° northern latitude with a max (0.9×10^{17} m^{-2}) in the late afternoon, a slow decrease during night time, a min (0.3×10^{17} m^{-2}) near sunrise, and a sharp increase after sunrise. A slight decrease of total electron content towards higher latitudes could also be deduced from these observations. (BBB)

5137 STUDIES OF AURORAL HYDROGEN EMISSIONS IN WEST-CENTRAL CANADA. II. VARIATIONS IN THE INTENSITY RATIO BETWEEN THE H_β LINE AND THE λ4709 N_2^+ BAND. Montbriand, L. E. (Defence Research Northern Lab., Fort Churchill, Man.); Jones, A. V. Can. J. Phys., 44: 3259-68(Dec. 1966).

The results of a large number of measurements of $R(H_\beta)$, the intensity ratio of the H_β auroral line, and the λ4709 (0,1) first negative N_2^+ band from Canadian IGY patrol spectrograms are presented. Only 3% of these ratios exceed unity, while half of them are less than 0.2. Comparison with a theoretical value of about 3.0 for proton excitation indicates that only a small fraction of aurora is so excited. The rare occurrence of values of $R(H_\beta)$ near 3.0 suggests that pure proton excitation does sometimes occur, however. Values of ratios of the brightness of H_β averaged over several spectrograms to those of λ4709 similarly averaged were shown to exhibit geomagnetic, latitudinal, and diurnal variations. The highest average ratios occur in the early evening, while the lowest values are observed in the late morning in post-breakup forms. The diurnal and latitude variations in these average ratios support the hypothesis that there is a zone of proton precipitation showing a characteristic behavior relative to the zones of electron excitation. (auth)

5138 A CONTRIBUTION TO THE VARIATION OF THE UNDISTURBED IONOSPHERE F2 CRITICAL FREQUENCY WITH THE TIME OF YEAR AND SOLAR ACTIVITY. Singler, Anton (Heinrich-Hertz-Institut, Berlin-Adlershof, Ger.). Beitr. Geophys., 75: 98-111(1966). (In German).

The variations, consisting of long periodic changes and short statistical fluctuations of ionization, of the undisturbed F2 layer critical frequency (ordinary component, f_0F2, station Juliusruh/Ruegen, $\phi = 54°38'$; $\lambda = 13°23'$) were quantitatively computed for the midday mean and the night-time minimum value of daily variation. The limits between the undisturbed and the disturbed daily variations were statistically determined by means of frequency distributions of daily midday mean values and night-time minimum values about the corresponding monthly medians. The disturbed values of critical frequencies lying outside of these limits may thus be neglected in the calculation of variations. (BBB)

5139 STUDY OF THE LOWER IONOSPHERE BY MEASURING NOISE IN THE VLF BAND. Tagliaferri, G. L. (Osservatorio Astrofisico, Arcetri, Italy). Nuovo Cimento (1), 3: Suppl., 613-20 (1965). (In Italian).

Recent studies are briefly summarized to show how measurement of the noise level of the vlf band can be used to obtain knowledge on solar phenomena, the high atmosphere, and interactions between solar radiation and the atmosphere itself. (J.S.R.)

5140 ELECTRONS IN THE VAN ALLEN ZONE MEASURED WITH A SCINTILLATOR ON EXPLORER 14. Pizzella, G.; Davis, L. R.; Williamson, J. M. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 71: 5495-5508(Dec. 1, 1966).

The energy spectrum of electrons in the energy range from 5 to 160 keV was investigated near the equator, at L shells between 2 and 10, by using scintillator measurements on Explorer 14. Results indicate the following: (1) peak values of 8×10^8 electrons/cm^2/sec with an average energy of ~50 keV at L ~ 5; (2) peak values of 1.6×10^9 electrons/cm^2/sec with an average energy of ~10 keV at $L \geq 8$; (3) time variations of intensity by factors of 10 or less above L ~ 4 during the 15 days of data under study; and (4) a discontinuity of the energy spectrum at L ~ 7, with a general tendency for the spectrum to become softer at higher L. The 10-keV electrons measured at L ~ 8 are trapped in the earth's magnetic field and appear not to be a tail of the outer belt electrons. These electrons are unable, without an accompanying replenishing mechanism, to supply the auroral regions. (auth)

5141 AMPLIFICATION OF IRREGULARITIES IN THE IONOSPHERE. Schrader, D. H.; Kan, J. R. (Washington State Univ., Pullman). J. Geophys. Res., 71: 5617-24(Dec. 1, 1966).

An evaluation of the applicability of Martyn's amplification mechanism to the explanation of the sunset peak in the occurrence of F-region field-aligned echoes was made. The vertical velocities of the ionization, necessary for amplification of ionization irregularities by this mechanism, were estimated from measured electron number-density profiles. The diurnal variation of this velocity was found to have downward peaks at sunrise and sunset of 25 ± 5 m/sec. The amplification was calculated for various geomagnetic latitudes, and it was found to be appreciable only at low latitudes if diffusion were negligible. The daytime and sunset amplifications were the same but were caused by drifts in opposite directions. Unless some further effects were caused by these oppositely directed drifts, Martyn's amplification mechanism cannot explain the sunset peaks even at low latitudes. (auth)

5142 SATELLITE STUDY OF VLF HISS. Gurnett, Donald A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 71: 5599-5615(Dec. 1, 1966).

Broad-band vlf radio noises from about 4 kc/s to above 10 kc are frequently observed near the auroral zone with the Injun 3 satellite. These broad-band vlf radio noises are called vlf hiss. The vlf hiss events are selected for analysis by requiring that the radio noise intensity from 5.5 to 8.8 kc exceed 3×10^{-10} gamma^2/cps (about 5 times the receiver noise level). During the 10-month lifetime of Injun 3 approximately 140 events occur that satisfy this criterion. The frequency spectra of the vlf hiss observed by Injun 3 is typically a flat noise spectrum with a distinct lower frequency cutoff. The lower frequency cutoff is often found to have a nearly symmetric latitude variation centered on a region of intense electron precipitation. The range of invariant latitudes (INV) for which vlf hiss typically occurs is about 7° wide and is centered on 77° INV at 12.0 hours magnetic local time (MLT), decreasing to 72° INV at 23.0 hours MLT. On the high-latitude side of the 40-keV trapping boundary, where vlf hiss usually occurs, intense fluxes of soft electrons are often accompanied by vlf hiss. It is found that the correlation between vlf hiss and intense fluxes ($j > 2.5 \times 10^7$ (cm^2 ster sec)$^{-1}$) of electrons (E > 10 keV) is dependent on the exponential folding energy E_0. The correlation is very good for E_0 from 3 to 4 keV but poor for larger E_0 values. (auth)

5143 NEGATIVE ION DETECTION IN THE IONOSPHERE FROM EFFECTS ON ELF WAVES. Shawhan, Stanley D. (Univ. of Iowa, Iowa City). J. Geophys. Res., 71: 5585-98(Dec. 1,1966).

The theory for propagation of small-amplitude electromagnetic waves in a cold, homogeneous plasma including negative ions and immersed in a uniform, static magnetic field is developed. It is found that for longitudinal propagation each negative ion introduces a resonance at the negative ion cyclotron frequency, a concentration dependent cutoff frequency above the negative ion cyclotron frequency, and possibly a crossover frequency depending on the ion concentrations and charge-to-mass ratios. At both the cyclotron frequency and the cutoff frequency the group refractive index becomes infinite. Between these two frequencies there is a "noise" frequency, for which the group refractive index is a minimum. Examples are given for a three- and five-component plasma. Application of this negative ion theory is made to propagation of negative ion whistlers in the ionosphere. It is found that for frequencies near the negative ion cyclotron frequencies the WKB approximation is valid above 300 km during the nighttime and 150 km during the daytime. Effects of collisions can be neglected above 150 km. An ideal experiment is proposed for observation of negative ion whistlers (1 to 1000 cps). Sample whistler, frequency-time spectrograms like those that would be observed with such an experiment are sketched. From the distinctive frequencies on these sample spectrograms, it is shown that the negative ion specie and concentration can be determined using the developed cold plasma expressions. (auth)

5144 OBLIQUE z-MODE ECHOES IN THE TOPSIDE IONOSPHERE. Calvert, W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Geophys. Res., 71: 5579-83 (Dec. 1, 1966).

On the topside sounder records, an echo trace is observed that lies between the plasma and upper hybrid frequencies and is not predicted for vertical propagation. It is shown by numerical ray tracing that these are z-mode echoes by oblique propagation between the satellite and the ordinary (X = 1) reflection level. (auth)

5145 RADAR SPECTROGRAPHIC ESTIMATES OF IONIC COMPOSITION FROM 225 TO 1400 KILOMETERS FOR SOLAR MINIMUM WINTER AND SUMMER CONDITIONS. Carlson, H. C.; Gordon, W. E. (Cornell Univ., Ithaca, N. Y.). J. Geophys. Res., 71: 5573-8(Dec. 1, 1966).

Observed diurnal variations of the ionic composition in the ionosphere over Arecibo are presented in the 225- to 1400-km altitude range for a typical winter and summer day under solar minimum geomagnetically undisturbed conditions. He^+ remains a minor constituent (about 20% or less) for all the times observed. In winter it is found to maximize at about 450 to 500 km at night and at about twice this altitude in the day; the transition from strongly dominant O^+ to strongly dominant H^+ takes place in a corresponding region whose extent is about 300 km at night but more like triple this in the day. In summer the transition region is somewhat higher and thicker. Sunrise and sunset rates of change of composition are greater in summer than winter, and the minimum altitude of the contours of constant composition is shifted from local sunrise in summer to roughly midnight in winter. These seasonal differences are ascribed to the effect of photoelectrons streaming from the magnetically conjugate ionosphere. (auth)

5146 IONIZATION TRANSPORT EFFECTS IN THE EQUATORIAL F REGION. Hanson, W. B.; Moffett, R. J. (Southwest

Center for Advanced Studies, Dallas). J. Geophys. Res., 71: 5559-72(Dec. 1, 1966).

Solutions of the continuity equation for electrons in the F2 region of the earth's ionosphere are obtained for the region near the magnetic equator under noon conditions. The physical processes of photoionization, recombination, diffusion, neutral winds, and electromagnetic drift are included explicitly in the equation; the presence of light ions (H^+,He^+) and the effects of ion drag, however, are specifically ignored. It is shown that upward plasma drift at the equator is very likely the cause of the Appleton anomaly, as originally suggested by Martyn; a drift velocity of about 10 m sec^{-1} is required. Other cases with downward drift or with neutral winds are presented. It is shown that a 15% interhemisphere asymmetry in the electron concentration at the Appleton peaks can be caused by a 60 m sec^{-1} neutral wind blowing from north to south. By using a very small drift velocity the time-dependent behavior of the electron concentration along particular field lines is investigated for different initial conditions. (auth)

5147 SPATIAL DISTRIBUTION OF ENERGETIC ELECTRONS IN THE GEOMAGNETIC TAIL. Murayama, Takashi (Univ. of Chicago). J. Geophys. Res., 71: 5547-57(Dec. 1, 1966).

Counting rates from a solid-state detector in the experiment of Fan, Gloeckler, and Simpson on the IMP 1 satellite were analyzed to investigate the spatial distribution of electrons with energies >30 keV in the geomagnetic tail and in the magnetosheath region surrounding the tail out to ~30 earth radii. The counting rates range from the background cosmic-ray level (~3 sec^{-1}) up to 10^3 sec^{-1} and have a positive correlation with the K_p geomagnetic field disturbance index. A multiple correlation analysis was made to investigate the spatial distribution of the electrons, which leads to the following results. Within the tail (1) the particle flux is a decreasing function of Z_n, the distance from the neutral sheet as determined by magnetic field observations on the same satellite by Ness, Scearce, and Seek. Z_n is found to be a better parameter for describing the electron distribution than the distance from either the ecliptic plane or the geomagnetic equatorial plane. (2) The radial dependence of the electron flux reported earlier by Anderson is shown to be due mostly to the spurious correlation between the radial distance and Z_n. (3) For a given constant Z_n, the flux is higher near the dawnside magnetospheric boundary than near the center of the tail. In the magnetosheath beyond the boundary of the tail, the electron flux decreases only gradually with increasing distance from the solar magnetospheric equatorial plane. The implications of these observations are discussed mainly in connection with the origin of the energetic electrons in the tail. (auth)

5148 ENERGY PRINCIPLES FOR THE CONFINEMENT OF A MAGNETIC FIELD. Maguire, J. J.; Carovillano, R. L. (Boston Coll., Chestnut Hill, Mass.). J. Geophys. Res., 71: 5533-9(Dec. 1, 1966).

Energy is expended and stored when a vacuum magnetic field is confined to a limited volume of space. This energy is analytically determined under conditions where the confinement is made quasi-statically by a perfectly diamagnetic medium. Special attention is given to a vacuum dipole field in the applications, but the established theorems apply to arbitrary superpositions of multipole fields as well. The energies required to confine the dipole field by a diamagnetic plane, sphere, hot plasma, and spheroid are explicitly calculated from the derived theorem. Of fundamental significance is the demonstration of how equilibrium boundaries can be predicted from a free surface variational principle based upon the proven energy theorem. (auth)

5149 TEMPORAL VARIATIONS OF ELECTRON INTENSITIES AT LOW ALTITUDES IN THE OUTER RADIATION ZONE AS OBSERVED WITH SATELLITE INJUN 3. Craven, John D. (Univ. of Iowa, Iowa City). J. Geophys. Res., 71: 5643-63 (Dec. 1, 1966).

Temporal variations of the intensities of electrons with E > 40 keV, E > 230 keV, and E > 1.6 MeV trapped in the outer radiation zone in the region $3.0 \leq L \leq 6.0$ and mirroring at altitudes of ~1500 km were studied during a seven-month period from January 1 to July 31, 1963, by means of three Geiger–Mueller tubes on board the research satellite Injun 3. From observations during some twenty geomagnetically disturbed periods, it is shown that the largest intensity variations occur at the onset of such disturbances and that subsequent behavior is dependent on the magnitudes of the disturbances as measured by the maximum daily sums of the planetary magnetic disturbance parameter, K_p. The time histories of these intensity variations are compared with those of 3-hour averages of the horizontal component of the geomagnetic field at College, Alaska (L = 5.5), for several disturbed periods. Nearly simultaneous measurements of the directional intensities of electrons (E > 40 keV), which mirror at low altitudes, with Injun 3, and omnidirectional intensities of these electrons near the geomagnetic equatorial plane, with Explorer 14, indicate similar temporal behavior at L ~ 4. The highest observed intensities of trapped electrons (E > 40 keV) in the outer zone at low altitudes appear to occur under a condition of approximate isotropy and equal omnidirectional intensities $\lesssim 10^8$ $(cm^2\ sec)^{-1}$ along a magnetic field line at all altitudes above several hundreds of kilometers. During four periods of post-disturbance geomagnetic calm, the intensities of electrons (E > 40 keV) were observed by Injun 3 to decrease exponentially in time with decay constants $\tau = 12 \pm 3$ days at L = 3.0, and $\tau = 4 \pm 2$ days in the region $3.5 \leq L \leq 6.0$. Simultaneously measured values of the decay constants for these electron intensities near the geomagnetic equatorial plane at L ~ 4 agree, within observational error. Long-term exponential decays in the intensities of artificially injected electrons (E > 1.6 MeV) were observed by Injun 3 to be characterized by $\tau = 40 \pm 5$ and 45 ± 5 days at L = 3.0 and 3.5, respectively. Further evidence for the diffusion of electrons (E > 1.6 MeV) is presented. (auth)

5150 A STUDY OF SPORADIC E AT HIGH LATITUDES. Taieb, C. C. (Franklin Inst., Swarthmore, Pa.). J. Geophys. Res., 71: 5757-61(Dec. 1, 1966).

The diurnal distribution of the occurrence of sporadic E at high latitudes during two periods in 1964 is determined from data provided by six IQSY ionospheric forward scatter paths in the arctic and antarctic regions. The relationship of the diurnal variation of E_s to geomagnetic activity is investigated and a transition zone, located between the auroral zone and the region closer to the geomagnetic pole, is found to be characterized by a maximum occurring earlier in the afternoon when $\Sigma k_p > 20$ than when $\Sigma k_p < 10$. Furthermore, a second maximum appears as geomagnetic activity increases. The diurnal variations at geomagnetically conjugate path midpoints are identical if the data are plotted as a function of geomagnetic time. It is suggested that three distinct zones of sporadic E can be identified with the properties of the local magnetic field lines. In the transition zone, the particles producing E_s appear to be precipitated as a consequence of the rotation of the earth. (auth)

5151 RELATION OF 5- TO 40-SECOND-PERIOD GEOMAGNETIC MICROPULSATIONS AND ELECTRON PRECIPITATION TO THE AURORAL SUBSTORM. Parks, G. K.; McPherron, R. L.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res., 71: 5743-5(Dec. 1, 1966).

An examination was made of energetic precipitation and geomagnetic micropulsations to show that x-ray microbursts and micropulsations in the 5- to 40-sec range are related. The occurrence times and durations of 25 x-ray microbursts at Flin Flon, Manitoba, Canada, were compared with riometer and micropulsation records at College, Alaska. The results showed that every x-ray microburst episode detected at Flin Flon was accompanied at the same universal time by geomagnetic micropulsation activity in the 5- to 40-sec range and by significant cosmic noise absorption at College, Alaska. The hourly scalings of geomagnetic micropulsation amplitude and period recorded at College are shown as a function of universal time for the four days in September 1965 during which microbursts were detected. The examination shows that x-ray microbursts, x-ray pulsations, and 5- to 40-sec micropulsations are associated with auroral substorms. (J.H.M.)

5152 FORMATION OF PLASMAPAUSE, OR MAGNETOSPHERIC PLASMA KNEE, BY THE COMBINED ACTION OF MAGNETOSPHERIC CONVECTION AND PLASMA ESCAPE FROM THE TAIL. Nishida, Atsuhiro (Tokyo Univ.). J. Geophys. Res., 71: 5669-79(Dec. 1, 1966).

Magnetospheric convection system proposed by Axford and Hines is revised and made compatible with the view, based on the recently obtained geomagnetic data, that (1) the convective motion induced by the solar wind would penetrate to the innermost part of the magnetosphere, if it were not for the superposed effect of the earth's rotation, and the fact that (2) the earth's magnetosphere has an essentially open tail. Magnetic lines of force in the magnetosphere are then found separated into two groups: those that travel across the tail during the convective motion and those that are never transported to the tail. On field lines of the former group, the plasma density would be less than the value expected on the basis of the equilibrium theory, since the plasma along these field lines can escape to the outer space while the field line travels across the open magnetospheric tail and since the rate of plasma replenishment from lower levels is low. On field lines of the latter group, plasma escape is always prevented by closed field lines, so that the diffusive equilibrium would prevail. Hence at the boundary between these two groups of field lines, the plasma density is expected to show discontinuity. This boundary surface is suggested to be the plasmapause, and various observed features of the plasmapause are explained. (auth)

5153 ORIGIN OF HYDROMAGNETIC EMISSIONS. Jacks, Bruce R. (Univ. of British Columbia, Vancouver). Earth Planet. Sci. Lett., 1: 467-70(Nov. 1966).

It has been suggested that structured hydromagnetic emissions result from the cyclotron excitation of left-hand polarized hydromagnetic waves by proton streams trapped in the magnetosphere. Consideration is given here to determination of the regions in the magnetosphere where the emissions occur. (J.H.M.)

5154 SIGNIFICANCE OF A VISIBLE LUNAR INFLUENCE ON THE SPECTRUM OF GEOMAGNETIC ACTIVITY. Meyer, J. (Univ., Goettingen, Ger.). Earth Planet. Sci. Lett., 1: 392-4 (Nov. 1966). (In German).

It is shown that the secondary maxima near 25.8 and 29.6 days in the spectrum of geomagnetic activity can fully be understood by an annual amplitude modulation in the recurrence tendency of M-type disturbarces. This disproves the necessity of assuming lunar influences on geomagnetic activity, in agreement with the result of Bartels. (auth)

5155 GEOMAGNETIC PULSATIONS ACCOMPANYING STORM SUDDEN COMMENCEMENTS AND SUDDEN IMPULSES. Voelker, H. (Univ., Goettingen, Ger.). Earth Planet. Sci. Lett., 1: 383-6(Nov. 1966).

The behavior of geomagnetic pulsations occurring simultaneously with ssc's and si's is discussed. The statistical results exhibit a distinct variation of the magnetospheric conditions for the excitation of pulsations with local time. It is shown that daytime effects are superimposed by pc-type pulsations with latitude dependent periods (increase of period with increasing geomagnetic latitude). At times about sunrise and sunset the ssc's and si's are frequently accompanied by pi2-type pulsations. The probability for a simultaneous generation of pulsations with ssc's and si's is least around local midnight. (auth)

5156 IONOSPHERIC DRIFTS MEASURED BY THE RADIO STAR SCINTILLATION TECHNIQUE. Chivers, H. J. A. (Univ. of Manchester, Eng.). Ann. Int. Geophys. Year, 33: 286-8(1965).

During the IGY, ionospheric drift measurements were made by observing the Cygnus radio source for several days each month. In the course of 18 months, 627 determinations of drift motion were made. The drift directions and speeds are plotted. (J.H.M.)

5157 DRIFT OBSERVATIONS DURING THE IGY AT HALLEY BAY. Bellchambers, W. H.; Piggott, W. R. (Radio Research Station, Slough, Eng.). Ann. Int. Geophys. Year, 33: 278-85(1965).

Analyses of the ionospheric drift observations are reported. Discussions are included on the methods of observation and drift velocities of the E and F regions. (J.H.M.)

5158 DRIFT MEASUREMENTS OF THE E REGION IN NORWAY AT KJELLER AND TROMSOE. Harang, Leiv (Norwegian Defence Research Establishment, Kjeller). Ann. Int. Geophys. Year, 33: 271-7(1965).

Ionospheric E-region drift measurements at 2.1 MHz were made at Kjeller and Tromsö by similar fadings received at three points placed in a right-angled triangle with bases of 130 m. The following data are reported from the Kjeller observations: hourly values of the E–W and N–S drift components during July and August of 1957, values of the E–W and N–S drift for the summer season during 1954–55 and 1957–58, wind vector diagrams for the periods of observation, and drift directions during the four seasons of the normal E (at daytime) and E_s (at nighttime). From the Tromsö observations, records of the amplitudes of E_s echoes over the E–W and N–S bases are shown, and examples of correlation ellipses and drift velocities of the E_s pattern are included. (J.H.M.)

5159 SEASONAL ANOMALIES OF DRIFT DIRECTIONS IN THE LOWER IONOSPHERE REVEALED BY SPACED RECEIVER MEASUREMENTS IN THE LF RANGE. Sprenger, K. (Observatorium fuer Ionosphaerenforschung, Kuehlungsborn, Ger.). Ann. Int. Geophys. Year, 33: 266-70(1965).

During the IGY and the IGC, ionospheric drift measurements in the low-frequency range were made at Kühlungsborn with closely spaced receivers. The sky wave of a CW radio transmitter at 245 kHz, 180 km NNW of the receiving site was observed, the ground wave being suppressed by loop aerials. Results indicate that the median drift velocity was 80 m/sec, with more than 90% of all values between 40 and 160 m/sec. A very narrow restriction of the drifts to the west–east direction was observed, and another feature of the results is that the drift often reverses very suddenly from the normal eastern direction to the opposite one, particularly in the evening hours of some weeks during spring and autumn. (J.H.M.)

5160 ANISOTROPY OF SMALL-SCALE IRREGULARITIES AND MOTIONS IN THE F2 LAYER. Kushnerevskii, Yu. V.; Zayarnaya, E. S. Ann. Int. Geophys. Year, 33: 258-63(1965).

Ionospheric irregularities are considerably anisotropic. The average axial ratio of the anisotropy ellipse was found to be about 2. The major axis tends to follow the direction of the magnetic meridian. The average sizes of small-scale irregularities along the major and minor axes of the ellipse are 1300 and 660 m, respectively. There is a reduction of size of about 1.4 times at night as compared to daytime. In general, lower values are obtained for the drift velocity of small-scale irregularities when correlation analysis is used instead of the similarity method. This is due to the effect of the rather rapid random movements with an average velocity of 107 m/sec in the F2 layer. The distribution of the ratios of random movement velocity to drift velocity shows that the most probable value of this ratio lies within the range 0.5 to 1.0, while its average value is 1.6. The drifts of small-scale irregularities in the F2 layer have some preferred directions, their orientation being westward at night and eastward in the daytime. The westward component predominates. The north–south component of the drift velocity is oriented northward at night and southward in the daytime, while the direction of the east–west component is to the west at night and to the east in the daytime. For the lifetime of small-scale irregularities an average of about 9.8 sec was obtained, this value varying from 10.6 sec in daytime to 7.4 sec in the dark hours. (auth)

5161 MAIN RESULTS OF INVESTIGATIONS OF THE IONOSPHERIC DRIFTS IN THE USSR FOR THE IGY/IGC. Mirkotan, S. F. (Moscow State Univ.). Ann. Int. Geophys. Year, 33: 243-57(1965).

The existence of irregularities and intensive regular movements (drifts, winds) are standard features of the ionosphere. In the lower ionosphere winds and drifts are observed with a dominating semidiurnal component. The value and direction of the drift changes with height, latitude and season; such influences are subject to diurnal variations. There is no relationship between drift in the E layer and magnetic activity. Although there is quantitative agreement with the tidal theory, there are some difficulties in numerical comparisons. In the F2 layer there is a steady drift which is primarily diurnal. Probably, the influence of the tidal lunar forces on the F region is weak. The drift in the F2 layer is connected with the magnetic activity. The drift results obtained from large-scale irregularities differ from those obtained from small-scale ones. These differences indicate the existence of two processes in the ionosphere. One is the real wind or drift of the medium, and the other might be plasma waves. The geomagnetic field has considerable influence on the form of ionospheric irregularities. The irregularities, particularly the large-scale ones, have an elongated shape along the geomagnetic field. Data available support the theory of the origin of drifts in the F2 layer due to the transit of the electric field from the E to the F2 layer, but the numerical comparison also indicates differences between the theory and the observations. In order to solve these problems further studies should include complex investigations applying various methods of observation: surface sounding, radioastronomical and meteor observations, and launching of rockets and satellites. The most promising and direct method is the application of rockets and satellites. (auth)

5162 GRADIENT INSTABILITIES AS POSSIBLE CAUSES OF IRREGULARITIES IN THE IONOSPHERE. Liu, C. H.; Yeh, K. C. (Univ. of Illinois, Urbana). Radio Sci., 1: 1283-91(Nov. 1966).

A theory is proposed to explain the production of certain irregularities in the ionosphere. It is found that the region of the ionosphere below the peak of the electron distribution may become unstable because of the joint effect of the gravitational field and the positive electron density gradient there. The unstable modes are found to correspond to quasi-transverse modes. For the case when only plasma is considered, the condition for instability to occur is $g\rho_p'/\nu\rho_p > \xi$, where g is the gravitational acceleration, ρ_p the plasma density, ρ_p' its height gradient, ν the ion-neutral collisional frequency, and ξ the effective attachment coefficient. When the coupling between plasma and neutral particles is taken into account, an additional instability condition may occur when the neutral particle distribution has a positive density gradient. This quasi-transverse unstable mode is proposed as a possible causative mechanism for the formation of irregularities in the ionosphere. When either one of the instability criteria is satisfied, spontaneous generation of irregularities is possible. Some experimental evidence is presented and discussed. (auth)

5163 DISCUSSION OF PAPER BY M. E. RASSBACH, A. J. DESSLER, AND A. G. W. CAMERON, "THE LUNAR PERIOD, THE SOLAR PERIOD, AND K_p." Bell, Barbara; Defouw, Richard J. (Harvard Coll. Observatory, Cambridge, Mass.). J. Geophys. Res., 71: 5770-3(Dec. 1, 1966).

In the paper noted above (J. Geophys. Res., 71: No. 17(1966)) it was argued that the variations of geomagnetic activity with lunar phase, attributed by some investigators (Bell and Defouw, 1964 and 1966, Stolov and Cameron, 1964, and Stolov, 1965) to an interaction between the moon and the magnetosphere, is actually due to the sun. They further state that these various authors were led astray because, in calculating statistical significance, they did not take account of the 27-day recurrence tendency or solar period in the indices of geomagnetic activity. The authors of this note admit that in their previous papers most of the statistical significances derived from 5-day running means of the K_p are indeed too high, since their equation did not include terms for the solar period. However, they do not feel that consideration of the 27-day solar period by Rassbach et al., demolishes all persuasive evidence for the existence of a lunar modulation of geomagnetic activity, nor is it felt that it establishes the apparent effect as resulting from the solar period. (J.H.M.)

5164 METHOD OF DETERMINING SOLAR COSMIC-RAY SPECTRA IN THE HIGH-ENERGY RANGE. Dorman, L. I.; Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 168-73 (1966).

Translated from Geomagn. Aeronomiya, 6: 215-22(1966).

The results are reported of computations of the total production multiplicity for a neutron monitor and an ionization chamber. The computations for the neutron monitor were performed on the basis of the latitudinal effect of the neutron component at sea level. The integral production multiplicity for the ionization chamber was computed from the latitudinal effect of the flare of February 23, 1956. The computed production multiplicities are used to obtain solar cosmic-ray spectra at the boundary of the atmosphere for the flare of February 23, 1956, in the range of rigidities 1 to 15 Bv. (auth)

5165 PROGRESS IN MAGNETOSPHERIC RADIO. Bowles, K. L.; Brace, L. H.; Carpenter, D. L.; Cohen, R.; Fejer, J. A.; Hanson, W. B.; Helliwell, R. A.; Scarf, F. L.; Smith, R. L.; Sugiura, M. Radio Sci., 1: 1363-70(Nov. 1966).

Brief discussions are presented on the magnetosphere, whistler knee and plasma pause, whistler attenuation, ulf noise of magnetospheric origin, ion effects related to new whistler phenomena, hydromagnetic disturbances, ion composition and diffusion above the F region, direct observations of ion composition and electron temperature, incoherent backscatter studies, and plasma resonances in the ionosphere. (M.O.W.)

5166 ELECTRON CONCENTRATION IN THE F1 LAYER AS A FUNCTION OF THE ZENITH ANGLE OF THE SUN. Serafimov, K. B. (Inst. of Geophysics, Academy of Sciences, Bulgaria). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 263-8 (1966).

Translated from Geomagn. Aeronomiya, 6: 334-40(1966).

The exponent, n, of the cosine law of a simple α layer is analyzed in relation to the maximum electron concentration in the F1 layer. Expressions are presented for obtaining n under nonstationary conditions and in the presence of temperature gradients and temperature variations. Analysis of the n values for the period 1957–1964 shows that solar activity has little effect on this exponent. The results obtained can be used to explain the partial compensation of temperature gradients by temporal temperature variations for a variable average mass of the ionized medium. (auth)

5167 TWO QUASI-CIRCULAR ZONES OF MAXIMUM MAGNETIC ACTIVITY. Vershinina, T. I.; Gorovoi, M. D.; Latypova, R. Kh.; Mishin, V. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 288-91(1966).

Translated from Geomagn. Aeronomiya, 6: 365-9(1966).

Curves of the latitudinal distribution of magnetic activity along 12 successive meridians of local geomagnetic time and "instantaneous" charts of zones of maximum magnetic activity and of zones of maximum latitudinal variation of activity are constructed. The two latter zones are quasi-circular zones centered on geomagnetic latitudes 66 and 77°. (auth)

5168 INTERMEDIARY ROLE OF THE MAGNETIC FIELDS OF SOLAR CORPUSCULAR STREAMS IN THE DETERMINATION OF THE DEGREE OF THEIR GEOPHYSICAL EFFECTIVENESS. Zhulin, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 296-7(1966).

Translated from Geomagn. Aeronomiya, 6: 375-6(1966).

The influence of the magnetic fields of solar corpuscular streams on the interaction of the streams with the earth's magnetosphere was previously discussed by Zhulin [Geomagn. Aeronomiya, 6: 197 (1966)]. Special attention was paid to the fact that it is impossible for the magnetic field of a stream to penetrate the magnetosphere, and to the subsequent need to interpret the theory of geomagnetic disturbances magnetohydrodynamically. The intermediary role of the magnetic field of a stream in the interaction of an advancing plasma with the earth's magnetosphere was discussed as one of the possible mechanisms determining the degree of geophysical effectiveness of corpuscular streams. This intermediary role is further specified in this brief note, which complements the referenced paper. (J.H.M.)

5169 VARIATIONS IN THE INTENSITY OF OUTER RADIATION BELT PROTONS AND ELECTRONS. Savenko, I. A.; Tel'tsov, M. V.; Shavrin, P. I. (Moscow State Univ.). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 298-300(1966).

Translated from Geomagn. Aeronomiya, 6: 377-9(1966).

Results are reported of an analysis of data from measurements of the intensity of outer-radiation-belt protons and electrons for the period from the end of August to the end of December, 1964. Characteristics of the radiometric equipment of the Cosmos 41 satellite are tabulated. (J.H.M.)

5170 ION FORMATION INTENSITY AT HEIGHTS OF 100 TO 300 KM. Ivanov-Kholodnyi, G. S. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 302-5(1966).

Translated from Geomagn. Aeronomiya, 6: 382-4(1966).

Rate of ion formation, q, in the ionosphere for various heights, h, and various zenith angles, $Z_\odot$, was investigated. The results of computations of q(h) profiles for various $Z_\odot$ are presented. The profiles are given for each region of the ionosphere, and consideration is given to low or high solar activity. The values obtained are compared with previous computations. (J.H.M.)

5171 RADIATION EXCITED BY A SHOCK WAVE AT THE MAGNETOSPHERE BOUNDARY. Kovner, M. S. (Gorkii State Univ., USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 189-92(1966).

Translated from Geomagn. Aeronomiya, 6: 241-5(1966).

Radio wave emission from the region of a head shock wave at the magnetosphere boundary is examined. An estimate is given of the electric field intensity of plasma waves, which is found to be ~ 25 mV/m. The scattering of shock waves on density fluctuations is investigated. The frequency of scattered electromagnetic radiation is $f \approx 100$ Hz. The flux density of this radiation is $S \approx 10^{-20}$ W/m^2 Hz. (auth)

5172 ELECTRON CONCENTRATION INHOMOGENEITIES APPEARING DURING THE PROPAGATION OF MOVING IONOSPHERIC DISTURBANCES. Gershman, B. N.; Grigorev, G. I. (Gorkii State Univ., USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 193-9(1966).

Translated from Geomagn. Aeronomiya, 6: 246-54(1966).

Problems concerning the theory of formation of electron concentration inhomogeneities appearing during the propagation of internal gravity waves at heights corresponding to the F layer of the ionosphere are analyzed. The conclusions of the theory are used to interpret the patterns associated with the preferred orientation of the directions of propagation of moving disturbances. An estimate is given of the degree of effectiveness of formation of inhomogeneities with allowance for the height dependence of the concentration of molecules. (auth)

5173 ANALYSIS OF EXPERIMENTAL DATA ON THE CONCENTRATIONS OF O_1 AND O_2 ABOVE THE LEVEL OF GRAVITATIONAL SEPARATION. Mirtov, B. A. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 225-30(1966).

Translated from Geomagn. Aeronomiya, 6: 284-91(1966).

The mixing time of the atmosphere and the lifetime of O_1 and O_2 are compared for heights of 120 km and more. It is found that above 140 to 150 km the distribution of O_1 concentrations must always be in strict agreement with its barometric distribution law. The same level for O_2 is found approximately at the same heights. This scheme is borne out by analysis of several experiments on the determination of O_1 and O_2 concentrations. The conclusion is reached that the most suitable method for measuring O_1 and O_2 concentrations at great heights in the atmosphere is optically. (auth)

5174 PHOTOCHEMICAL EQUILIBRIUM OF ATMOSPHERIC OXYGEN AT HEIGHTS EXCEEDING 150 KM. Mirtov, B. A. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 231-5(1966).

Translated from Geomagn. Aeronomiya, 6: 292-7(1966).

A theory of the photochemical equilibrium of oxygen at heights exceeding 140 km is developed on the assumption of the predominant role of the radiative recombination reaction in the recombination of oxygen atoms at heights in excess of 120 km. For a steady-state regime use is made of the equation of photochemical equilibrium together with experimental data on O_1 and O_2 concentrations in the high layers of the atmosphere and the coefficient of radiative recombination α, is computed. The variations of the $[O_2]/[O_1]^2$ ratio from experiment to experiment suggest that the measured O_1 and O_2 concentrations deviate from the steady-state equilibrium, i.e., deviate from photochemical equilibrium under real atmospheric conditions. (auth)

5175 AURORAL ZONE. Mal'ko, L. N. (Polar Geophysical Inst., Kola Branch, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 243-6(1966).

Translated from Geomagn. Aeronomiya, 6: 307-11(1966).

The variation of the position of the auroral zone and of the southern auroral boundary is investigated as a function of the magnetic activity level and of the time of day. Data for the 1962–1963 season are compared with the data for the IGY period. (auth)

5176 AURORAS IN MAGNETICALLY DISTURBED AND MAGNETICALLY QUIET PERIODS. Fel'dshtein, Ya. I.; Shevnina, N. F.; Lukina, L. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 247-53 (1966).

Translated from Geomagn. Aeronomiya, 6: 312-21(1966).

The distribution of auroral frequency at the zenith as a function of latitude is examined on the basis of observations by a network of all-sky cameras in 1957–1959 and 1963–1965 for magnetically quiet ($K_p \leq 1$) and magnetically disturbed ($K_p \geq 5$) periods. The position of the auroral zone on the night and day sides of the earth is obtained for $K_p \leq 1$ and $K_p \geq 5$ and the existence of a marked asymmetry both in magnetically quiet and magnetically disturbed periods is demonstrated. Cyclic variations in auroral frequency at night are discussed. The latitudinal distribution of average diurnal auroral frequencies is obtained. It is shown that the concept of an oval current zone at higher latitudes during the daytime and lower latitudes at night agrees well with the relationship between ΔT_{hor} at Tromso and at Tikhaya Bay and with the distribution of magnetic activity at Canadian stations. (auth)

5177 VARIATIONS OF MAXIMUM ELECTRON CONCENTRATION IN THE F2 LAYER WITH SOLAR ACTIVITY. Kerblay, T. S. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 254-7(1966).

Translated from Geomagn. Aeronomiya, 6: 322-6(1966).

Computed estimates of the dependence of N_mF2 on solar activity are compared with the results of ionospheric observations. The conclusion is reached that the presently known solar-cycle variations in the temperature of the upper atmosphere can explain the form of the relationship $N_m(R)$ for a daytime, middle-latitude ionosphere. (auth)

5178 MEASUREMENT OF RAPID-PHASE FLUCTUATIONS OF A SIGNAL REFLECTED FROM THE IONOSPHERE. Gaylit, T. A. (Moscow State Univ.). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 258-62(1966).

Translated from Geomagn. Aeronomiya, 6: 327-33(1966).

The physical nature of rapid (1-sec) phase fluctuations of a signal reflected from the F2 layer in vertical sounding is investigated. A phase meter is described which makes it possible to measure phase differences with an accuracy of 3 to 4°. The results are presented of simultaneous measurements of the fluctuations in the amplitude, phase, and rate of phase change of a signal reflected from the ionosphere. (auth)

5179 DIFFUSION OF CHARGED PARTICLES AT MIDDLE LATITUDES IN THE F REGION OF THE IONOSPHERE. Polyakov, V. M. (Zhdanov Irkutsk State Univ., USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 269-77(1966).

Translated from Geomagn. Aeronomiya, 6: 341-51(1966).

The vertical profile is presented of electron concentration distribution in the F2 layer of the ionosphere, resulting from the vertical diffusion of an electron–ion gas. It is shown that the Chapman distribution of electron concentration in the upper part and at the maximum of the layer is close to diffusive equilibrium. Deviation from equilibrium causes the transport of charged particles from the upper to the lower half of the layer in such a manner that the diversion of the diffusion flux in the vicinity of the F2-layer maximum changes sign and, therefore, remains insignificant. The rate of interdiffusion of various kinds of positive ions in the electron–ion gas without disruption of plasma neutrality is estimated. It is found that independent ion diffusion is strongly hampered. (auth)

5180 IONIZATION OF THE E REGION AND SOLAR X RAYS IN THE RANGE 44 TO 60 A. Letfus, V.; Serafimov, K. (Astronomical Inst., Academy of Sciences, Czech. Geophysical Inst., Academy of Sciences, Bulgaria). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 278-81(1966).

Translated from Geomagn. Aeronomiya, 6: 352-6(1966).

When computing the characteristics numbers of the E region one must eliminate the seasonal variation of aeronomic parameters and allow for temperature variations with height and time. For this purpose it is appropriate to construct a graph of the annual dependence of the characteristic numbers on the zenith angle of the sun. The characteristic numbers thus obtained in a year of the quiet sun (1964) at one station agree well with the intensity of solar x rays in the range 44 to 60 Å. (auth)

5181 APPEARANCE OF THE E_s LAYER IN THE AURORAL ZONE. Samardzhiev, D. (Geophysical Inst., Academy of Sciences, Bulgaria). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 282-4(1966).

Translated from Geomagn. Aeronomiya, 6: 357-60(1966).

The data from Murmansk for one year (1958) are used to investigate the diurnal and seasonal variations of the probability of appearance of an E_s layer, PE_s, the relative P_1E_s number for layers with frequencies $f_0E_s \geq 3$ MHz, and the probability of appearance of f_{min} with frequencies of $\geq$3 MHz (Pf_{min}). It is shown that Pf_{min} has a maximum in the noon hours. The diurnal dependences of PE_s and Pf_{min} are compared. There is an inverse correlation ($R > 70\%$) between these characteristics. The conclusion is reached that the known diurnal pattern of PE_s with minimum values near noon is strongly affected by f_{min}, since in this interval Pf_{min} has its maximum values. No diurnal and seasonal dependences were found in the pattern of P_1E_s. (auth)

5182 AURORAL RADIO WAVE ABSORPTION IN THE VICINITY OF THE GEOGRAPHIC NORTH POLE. Driatskii, V. M. (Arctic and Antarctic Scientific Research Inst.). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 285-7(1966).

Translated from Geomagn. Aeronomiya, 6: 361-4(1966).

The results of cosmic radio noise records made at North Pole-10, drifting in the vicinity of the geographic North Pole in the winter of 1963–1964, are examined. The diurnal pattern of auroral absorption is obtained and its relationship to similar phenomena in the auroral zone is established. The effective collision frequency, the frequency dependence, and the height of the absorbing region are computed from noise records at frequencies of 32 and 40 MHz. (auth)

5183 ELECTRON CONCENTRATION OVER MURMANSK AT VARIOUS SOLAR ACTIVITY LEVELS. Sukhorukova, E. V. (Polar Geophysical Inst., Kola Branch, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 305-9 (1966).

Translated from Geomagn. Aeronomiya, 6: 385-8(1966).

A study was made to explain the relationship between solar radiation and the number of electrons forming in a unit column to the level of the layer maximum. For the computations the most quiet day in each month from 1954 to 1963 was selected considering five magnetically quiet days of the month. This criterion was used to reduce to the minimum the effect of corpuscular ionization and to analyze the variation of electron concentration produced by solar ultraviolet radiation. Since the number of electrons forming in the ionosphere depends not only on solar radiation, but also on the physical conditions of the medium in which these electrons form, consideration was given to those parameters of the medium which will change with changing solar activity level. The level of maximum electron concentration changes with the solar cycle is shown for each month. (J.H.M.)

5184 RELATIONSHIP BETWEEN f_0F2 VALUES AT HIGH-LATITUDE STATIONS IN THE NORTHERN HEMISPHERE. Kiyanovskii, M. P.; Yudovich, L. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 309-11(1966).

Translated from Geomagn. Aeronomiya, 6: 389-91(1966).

To estimate the relationship of f_0F2 variations observed at different pairs of high-latitude stations, the cross-correlation coefficient, r, between f_0F2 values relating to a definite instant of time, was computed. The data for the period from September 1957 through February 1958 were used. The r values were computed for the following pairs of stations: (1) two stations in the polar region; (2) two stations in the auroral zone; and (3) one station in the polar region and the other in the zone. The variations of the correlation coefficient at various hours UT are given for the following pairs of stations: Alert–Eureka, Eureka–Kiruna, Eureka–Tikhaya, and Tikhaya–Kiruna. (J.H.M.)

5185 CYCLIC CURVES OF CRITICAL F2-LAYER FREQUENCIES AS A BASIS FOR FORECASTING f_0F2 FOR ANY PHASE OF THE SOLAR CYCLE. Novysh-Bylinskaya, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 312-14(1966).

Translated from Geomagn. Aeronomiya, 6: 392-6(1966).

Long-period observations of critical F2-layer frequencies at a network of ionospheric stations are analyzed with the purpose of finding a new basis for forecasting f_0F2. The observations of the stations (median f_0F2 values) are presented in the form of cyclic curves. (J.H.M.)

5186 ONE OF THE POSSIBLE MECHANISMS OF FORMATION OF THIN SPORADIC IONOSPHERIC LAYERS. Ivanov-Kholodnyi, G. S.; Lazarev, V. I. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 317-19(1966).

Translated from Geomagn. Aeronomiya, 6: 398-9(1966).

An examination is made of E_s layers that were investigated by rockets. Data are tabulated on the height, width, and electron concentration of these layers. The results of computations for electrons of energy $E_s = 30$ and 100 keV for a geomagnetic latitude of ~45° at a height of 110 km are presented. (J.H.M.)

5187 INFLUENCE OF IONIZATION GRADIENTS IN A LAYER WITH INHOMOGENEITIES ON THE CORRELATION OF FLUCTUATIONS AT VARIOUS FREQUENCIES. Erukhimov, L. M. (Gorkii State Univ., USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 319-21(1966).

Translated from Geomagn. Aeronomiya, 6: 400-1(1966).

To study the frequency correlation of radio waves in the ionosphere, an examination is made of the normal incidence of a plane wave upon a layer with inhomogeneities containing also large-scale ionization gradients. Curves are shown of the time functions of the frequency correlation at frequencies of 13-18, 13-14, and 18-40 MHz for October 12, 1963, in a period when the ionosphere was disturbed. (J.H.M.)

5188 SPACE–TIME VARIATIONS OF THE PARAMETERS OF Pc1 FLUCTUATIONS. Vinogradov, P. A.; Vinogradova, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, Siberian SSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 321-5(1966).

Translated from Geomagn. Aeronomiya, 6: 402-5(1966).

Simultaneous coordinated observations made at the beginning of the IQSY are used to make a comparative analysis of the regime of Pc1 fluctuations at points separated 60° in longitude and 20° in latitude. The total duration of Pc1 fluctuations of various intensities according to observations at Mondes in January–May of 1964 is presented. A photocopy of a tellurogram from Mondes, illustrating the Pc1 regime, is shown. Graphs are included of the simultaneous space variation of the Pc1 amplitude, obtained from the values of maximum amplitude for every minute (1 at Erkutsk, 2 at Petropavlovsk, and 3 at Yuzhno–Sakhalinsk). Also, the average Pc1 frequency is given for each station. (J.H.M.)

5189 GEOPHYSICAL EFFECTIVENESS OF SOLAR CORPUSCULAR STREAMS. Zhulin, I. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 154-9(1966).

Translated from Geomagn. Aeronomiya, 6: 197-204(1966).

It is noted that the magnetic field of solar corpuscular streams plays the role of an intermediary in the interaction of streams with the earth's magnetosphere, leading to an increase of the effective cross section of interaction, determining the possibility of the injection of solar plasma into the earth's magnetosphere, changing the extent of the friction effect during interaction, etc. The conservation of a magnetic flux, the impossibility of the penetration of the field of a stream into the earth's magnetosphere, and the associated necessity for a magnetohydrodynamic interpretation of the theory of geomagnetic disturbances are examined. The possible mechanisms for the transfer of energy to the earth's magnetosphere are discussed. (auth)

5190 CHARACTER OF VARIATION OF SOLAR WIND PARAMETERS, OF THE SHAPE OF THE MAGNETOSPHERE, AND OF THE MAGNETIC FIELD DURING MAGNETIC STORMS. Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 160-7(1966).

Translated from Geomagn. Aeronomiya, 6: 205-14(1966).

The interaction of a corpuscular stream with the earth's magnetosphere is examined. The shape of the magnetosphere and magnetic field disturbance in the vicinity of the earth are determined. It is shown that the magnitude of the increase of the H component on earth during the first phase of a storm depends strongly on the change in the shape of the magnetosphere. As the parameters of a stream that correspond to the passage of a shock wave from the sun, which produces a magnetic storm with a sudden commencement, change, the magnetosphere becomes less elongated. This strongly enhances the effect of the increase of the field on earth during the first phase as compared to the case when only the dayside of the magnetosphere contracts in streams with a high dynamic pressure with which storms without a sudden commencement can be identified. (auth)

5191 COMETS IN THE SOLAR WIND. II. Ioffe, Z. M. (Gorkii Univ., USSR). Soviet Astron.-AJ (Engl. Transl.), 10: 517-19(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 655-8(May-June 1966).

A comet is treated as a source embedded in a supersonic stream. The problem of stationary supersonic flow of a compressible gas stream around a subsonic source is formulated. The stream–source interface approaches a cylinder at infinity. The minimum source radius r_{min} characterizing the ionization region is found. The asymptotic values of the thermodynamic parameters yield the parameters near the sphere r_{min}. (auth)

5192 ACCELERATION OF PARTICLES IN COSMIC PLASMA. Gintsburg, M. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Propagation, Academy of Sciences, USSR). Soviet Astron.-AJ (Engl. Transl.), 10: 434-6(Nov.-Dec. 1966).

Translated from Astron. Zh., 43: 550-2(May-June 1966).

Processes of electron and ion acceleration by nonlinear waves in plasma are analyzed. The role of these processes in the origin of radiation belts is discussed. (auth)

5193 CONTINUOUS RECORDS OF THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE. Titheridge, J. E. (Univ. of Auckland, New Zealand). J. Atmos. Terrest. Phys., 28: 1135-50(Dec. 1966).

Equipment is described for automatic recording of the polarization angle of the 137-Mc signal from the geostationary satellite Syncom 3. Clear, unambiguous records are obtained from a weak signal, with a time resolution of about 10 sec. The records can be scaled to read directly in terms of the total electron content of the ionosphere (N_T). A long-term accuracy of better than 1% is easily obtained, while rapid changes of only 0.1% in N_T can be observed. Results obtained at Auckland from June 1965 to April 1966 are presented. Ionospheric irregularities cause fluctuations of up to 10% in N_T, while the day-to-day variations in N_T are 20% less than the changes in the peak density N_m. Monthly median curves show a diurnal range of about 2.5 : 1 in winter and 3 : 1 in summer; less than half as large as corresponding results from the northern hemisphere. A sudden change from winter to summer conditions suggests that the symmetrical equinox form of the upper atmosphere is unstable. Measurements at sunrise give an integrated production rate for an overhead Sun of $0.9\ (\pm 0.2) \times 10^{14}$ electrons $m^{-2}\ sec^{-1}$. This agrees with results obtained from ionograms if the loss coefficient in the F1 region is $10^{-14}\ m^3\ sec^{-1}$. Measurements at sunset give an effective recombination coefficient β' of $1.2 \times 10^{-4}\ sec^{-1}$ in winter and $0.5 \times 10^{-4}\ sec^{-1}$ in summer. These figures agree with observations of the rate of change of the critical frequency, showing that the ionization decays at the same rate at all heights. (auth)

5194 A STUDY OF THE NOON ELECTRON DENSITY VARIATION OF THE F2 LAYER AT LOW LATITUDES. Huang, Chunming (Radio Wave Research Labs., Taipei, Taiwan). J. Atmos. Terrest. Phys., 28: 1151-66(Dec. 1966).

In this study of the dynamic structure of the F2 layer, two photochemical and two transport processes are treated at first, taking into account the variable scale height and the conditions appropriate to the low-latitude ionosphere. All of them are put into forms which are suitable for computation and incorporated into the equation of continuity. The coefficients of photochemical reactions and transport processes are then determined in such a way that the equation of continuity is well satisfied by observational data under the restriction that the coefficients lie in the range of physical significance. The computations suggest that electromagnetic drift is an important transport process, while diffusion is perhaps negligible below the peak of the F2 layer. For a level of 300 km, the following were obtained: 1100 electrons $cm^{-3}\ sec^{-1}$ for the rate of electron production, 2.6×10^{-4}–$4.6 \times 10^{-4}\ sec^{-1}$ for the effective attachment coefficient, and approximately 40 m sec^{-1} for the electromagnetic drift velocity at the equator. A temperature difference of about 140°K between the geographic equator and 17°N latitude must be assumed in order to obtain justifiable values of the parameters. There is a possibility that the geomagnetic control could be explained with the above processes, but a definite conclusion cannot be reached without more reliable knowledge of the neutral atmosphere. A modification of the ordinary method of least squares is proposed, based on contradictions encountered in the course of computations. (auth)

5195 THE MORPHOLOGY OF THE VHF RADIO AURORA AT SUNSPOT MAXIMUM. I. DIURNAL AND SEASONAL VARIATIONS. Unwin, R. S. (PEL Auroral Station, Omakau, New Zealand). J. Atmos. Terrest. Phys., 28: 1167-81(Dec. 1966).

A statistical analysis of the occurrence of auroral echoes observed at 55 Mc on radar at Bluff, New Zealand, in 1958 is presented. It reveals important changes in the shape of the diurnal variation curve with the level of magnetic disturbance, and a seasonal variation with peaks at the equinoxes independent of magnetic disturbance. Comparison of the results with those from other workers in both hemispheres reveals a consistent overall picture. The radio aurora can be associated with three separate spirals in geomagnetic latitude and time, extending from mid latitudes deep into the polar cap. The position and relative prominence of the spirals is sensitive to the level of magnetic disturbance. They are similar to the spirals of maximum magnetic agitation derived by Feldstein (1963) and others. A brief comparison is made between the distributions in space and time of the radio and visual aurora. (auth)

5196 THE MORPHOLOGY OF THE VHF RADIO AURORA AT SUNSPOT MAXIMUM. II. THE BEHAVIOR OF DIFFERENT ECHO TYPES. Unwin, R. S. (PEL Auroral Station, Omakau, New Zealand). J. Atmos. Terrest. Phys., 28: 1183-94(Dec. 1966).

In Part I of this paper it was shown that the radio aurora as observed at vhf tended to fall in three separate spirals in geomagnetic latitude and time extending from sub-auroral latitudes to the polar cap. They were termed the E (evening), N (night), and M (morning) spirals. The behavior of the four different radar echo types observed at 55 Mc from Bluff, New Zealand, is examined; it is shown that diffuse echoes are predominantly associated with the E spiral, diffuse echoes with structure and short discrete echoes with the N spiral, and long discrete echoes with the M spiral. Diffuse echoes show a number of differences from the other types, namely a closer correlation with the planetary magnetic index, K_p, than with the local K index, and differences in seasonal behavior. All echo types tend to persist for one to three hours once they occur. (auth)

5197 IONIZATION BY LYMAN-α IN THE E REGION AT SUNRISE. Smith, L. G. (GCA Corp., Bedford, Mass.). J. Atmos. Terrest. Phys., 28: 1195-1205(Dec. 1966).

Rocket observations of electron density prior to ground sunrise are described. It is found that the initial increase of electron density in the upper E region coincides with the illumination of that region by Lyman-α radiation. Assuming that nitric oxide is the constituent being ionized by this radiation, it is deduced that the concentration is $(8 \pm 1) \times 10^{8}$ cm^{-3} between 130 and 150 km, in good agreement with theoretical estimates. (auth)

5198 CONTROL OF EQUATORIAL SPREAD F BY THE F LAYER HEIGHT. Narasinga Rao, B. C. (National Physical Lab., New Delhi). J. Atmos. Terrest. Phys., 28: 1207-17(Dec. 1966).

The dependence of equatorial spread-F occurrence on the height of the layer is examined in detail in the case of two equatorial stations viz. Kodaikanal and Huancayo, lying close to the magnetic equator. The percentage of occurrence associated with different heights is found to vary with time, season and longitude. The nocturnal variations of h′F on spread-F nights and non-spread-F nights suggest that h′F has to cross a threshold value of about 400 km for the production of spread F. The percentage of occurrence is more during the period when h′F is decreasing than when it is increasing. These observations can not be readily explained by the existing theories of spread F in their present form. A probable mechanism in which the spread F is caused by the plasma waves generated by the upward lifting of the layer across the horizontal magnetic field is suggested to account for the observed features. (auth)

5199 SYNODIC TENDENCIES IN THE TIME SERIES OF f_{min} AT SOUTH POLE, ANTARCTICA. Bennett, S. M. (Avco Corp., Wilmington, Mass.). J. Atmos. Terrest. Phys., 28: 1219-25(Dec. 1966).

At least three contemporaneous sequences of synodic polar cap absorption events (PCA) were identified in the time series of ionosonde f_{min} obtained at the Antarctic station, South Pole, at maximum epoch of the recent solar cycle (1958). The sequence synodic periods (27.45, 27.45, and 27.2 days) are characteristic of the rotation of moderately low latitude regions of the sun. These results support the interpretation of similar synodic sequences which occurred in 1961, associated with MeV proton streams in interplanetary space. Due to the proliferation of solar active regions at sunspot maximum, several proton streams may exist contemporaneously. It is concluded that the magnetic structures in interplanetary space, responsible for the guidance of MeV solar protons, existed for a substantial portion of the maximum and waning phases of the recent solar cycle. (auth)

5200 FORECASTING AURORAL SPORADIC E WITH A MAGNETOMETER. Morgan, A. D. (Government Communications Headquarters, Cheltenham, Eng.). J. Atmos. Terrest. Phys., 28: 1233-7(Dec. 1966).

Large disturbances of the earth's magnetic field outside the auroral zone are often accompanied by intense sporadic-E in the auroral zone. In general, the disturbance of the magnetic field precedes the increase in sporadic-E which suggests that a magnetometer can, to some extent, be used to forecast auroral sporadic-E. (auth)

5201 DOPPLER PROFILES OF THE 5577 A AIRGLOW. Hays, P. B.; Walker, J. C. G. (Queen's Univ., Belfast). Planet. Space Sci., 14: 1331-7(Dec. 1966).

The altitude and intensity of the nocturnal green line emission resulting from O_2^+ recombination is discussed. The Doppler profile of this emission is markedly nonthermal, the width being characteristic of the energy at which the $O(^1S)$ atoms are produced. A simple theory is formulated which predicts the profile of this line. Experimental evidence on airglow line profiles is reviewed and it is found that the effect predicted here has not yet been observed. However a deliberate search for this effect should yield immediate results. (auth)

5202 TWILIGHT EFFECTS OF SOLAR IONIZING RADIATION. Dalgarno, A. (Queen's Univ., Belfast); McElroy, Michael B. Planet. Space Sci., 14: 1321-9(Dec. 1966).

The absorption of solar ionizing radiation during twilight is investigated. Ion production rates are obtained as a function of altitude and twilight intensities and altitude profiles of emissions arising from the fluorescence of solar ionizing radiation are calculated for various solar depression angles. For an atmosphere with an exospheric temperature of 750°K, the predicted overhead intensity from fluorescence of the $O^+(^2P-^2D)$ lines at 7319 to 7330 diminishes from 175 R at dusk to 10 R at a solar depression angle of 10°. The predicted overhead intensities from fluorescence of the N_2^+ Meinel and first negative systems are respectively about 175 R and 20 R at dusk diminishing to respectively 1.5 R and 0.1 R at a solar depression angle of 10°. It is suggested that a charge transfer reaction of $O^+(^2D)$ in N_2 is a significant source of N_2^+ ions. This reaction offers a possible explanation for the high apparent rotational temperatures in the first negative system observed by Broadfoot and Hunten. Other excitation and ionization mechanisms are briefly discussed. (auth)

5203 N_2^+ EMISSION IN THE TWILIGHT. Broadfoot, A. L.; Hunten, D. M. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci., 14: 1303-19(Dec. 1966).

About a year's observations of the N_2^+ band (3914 Å) at Kitt Peak (latitude 32°) are reported. Morning intensities are the same throughout the year, but there is a strong winter maximum in the evening. It is suggested that the additional ionization is produced by photoelectrons from the magnetic conjugate point. Heights are estimated by the zenith–horizon method, which gives 235 km for the constant component and 350 km during the evening enhancement. The intensity variation through twilight is therefore entirely due to changes of the N_2^+ concentration; each ion scatters light at a constant rate. The rotational distribution resembles that for a temperature of 1600°K, much higher than the temperature of the atmosphere. It is suggested that part of the ions may be produced by charge transfer from metastable $O^+(^2D)$. N_2^+ concentrations resulting from photoionization are calculated; they give a fair account of the observed horizon intensities, but not the zenith. Non-local electrons from higher in the atmosphere are suggested as a possible extra source; alternatively, the zenith measurements may be perturbed by scattered horizon light. The band intensity in the nightglow cannot be measured; the upper limit is 1 R. (auth)

5204 GEOMETRICAL METHODS OF FINDING REFRACTIVE INDEX, ABSORPTION INDEX, AND POLARIZATION PARAMETERS OF RADIO WAVES IN THE IONOSPHERE. Banerjee, S. K. (University Coll. of Science, Calcutta). Proc. Nat. Inst. Sci. India, Pt. A, 31: 455-8(Sept. 1965).

Geometrical methods of determining the refractive index, absorption coefficient, and polarization parameters of the radio wave travelling through the ionosphere are given. (auth)

Low-Temperature Physics

Refer also to abstracts 4651 and 4738.

5205 (COO-1569-4) GYROSCOPIC DETECTION OF PERSISTENT FLOW OF SUPERFLUID HELIUM AND ASSOCIATED STUDIES. Mehl, James Bernard (Minnesota Univ., Minneapolis). Dec. 1966. Contract AT(11-1)-1569. 115p. DTIE. Thesis.

Persistent circulating currents of superfluid helium were observed and studied by a gyroscopic technique. The liquid helium container was a thin glass sphere packed with a fine powder. Persistent superfluid flow was set up in the channels formed by the network of interstices of the packed powder. The circulating currents of superfluid were prepared both by (1) cooling the helium-filled sphere through the transition temperature in rotation, and (2) by rotating the sphere rapidly at a temperature below the transition temperature after cooling without rotation. Following both methods of preparation, the angular momentum of the persistent current which remained after stopping rotation of the sphere was measured by measuring the torque necessary to reorient the sphere. Assuming that the persistent angular momentum is fixed in the sphere, this torque gives a direct and repeatable measure of the persistent angular momentum. In addition to persistent current studies, the work includes studies of superfluid flow in the powder-filled sphere using a variation of the classic Andronikashvili pile-of-disks technique. The oscillating pile of disks was replaced by the powder-filled sphere. An analysis of the flow of superfluid in a complicated multiply connected region, such as the inside of the powder-filled sphere, was made. Under the experimental conditions, the superfluid flow is potential. The results of the analysis were used to explain the properties of persistent currents as well as the flow of the superfluid in the oscillating powder-filled sphere. The main results of the experimental work are: (1) Persistent currents of superfluid flow with a great deal of stability can exist. The angular momentum of such currents appears to be fixed in the helium container. (2) The currents have a long lifetime. With flow channels with 10^{-4} cm lateral dimension, the observed lifetime is at least 10^{11} times longer than the theoretical lifetime of similar currents of liquid helium at temperatures above the transition temperature. (3) The persistent angular momentum is a reversible function of temperature as long as the temperature is not changed too rapidly. (4) When rotating liquid helium is cooled through the transition temperature, the superfluid is formed in a state with the angular momentum approximately equal to the solid body value. This result was verified only for sufficiently small angular velocities of preparation. (5) Critical velocity effects were observed when preparation of persistent currents was attempted at sufficiently high angular velocities. The observed critical velocities are in agreement with values observed in other experiments with superfluid flow channels of the same characteristic size. (auth)

5206 (IAE-1178) KRIOSTATY NOVOGO TIPA DLYA SVERKHPROVODYASHCHIKH SOLENOIDOV. (New Type Cryostats for Superconducting Solenoids). Keilin, V. E. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). 1966. 12p. (In Russian). Dep. mn.

The construction of cryostats with wide openings is described. They are particularly convenient for the experimental work with large-scale superconducting solenoids. The functions of the heat bridge and the screen are joined in a single unit. Such cryostats may be used also without the screen cooled by liquid nitrogen. The rate of helium evaporation is at the same time approximately the same as in the cryostats of corresponding dimensions with nitrogen screening (for instance, a cryostat with internal diameter of 200 mm evaporates about 600 to 700 cm^3/hour of liquid helium). During work with a nitrogen screen one can significantly reduce the rate of helium evaporation. Several versions of such cryostats with transparent central opening were built and tested. These cryostats are distinguished by a high strength and reliability, with a simplest possible construction. Cryostats of the same type with an internal diameter of more than 300 mm are described. (JPRS)

5207 (LA-DC-7907) THE DIELECTRIC CONSTANT OF ^{3}He. Kerr, E. C.; Sherman, R. H. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 5p. (CONF-660816-2). DTIE.

From 10th International Conference on Low Temperature Physics, Moscow, USSR.

An experiment is described in which an attempt was made to answer the question, "To what extent is the polarizability dependent on density and temperature?" The ^{3}He used was purified by distillation and mass spectroscopic analysis showed a purity of 99.9997%, the remainder being ^{4}He. (W.D.M.)

5208 (NASA-TN-D-3745) EFFECT OF TENSILE STRESS ON CURRENT-CARRYING CAPACITY OF COMMERCIAL SUPERCONDUCTORS. Hudson, Wayne R. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1966. 12p. CFSTI $3.00 cy, $0.65 mn.

An experimental investigation was performed to determine the effect of tension on the critical current of niobium–zirconium (NbZr) wire and niobium–tin (Nb_3Sn) ribbon at liquid-helium temperature, 4.2°K. The critical currents of the Nb_2Sn samples were measured at 4.14 teslas from zero tension to the breaking point. The critical currents of the NbZr samples were measured at zero magnetic field from zero tension to the breaking point. Critical current characteristics were investigated with the Nb_3Sn sample length both parallel and transverse to the magnetic field. The experimental samples consisted of commercially available NbZr wire and Nb_3Sn vapor deposited on stainless steel ribbon. The experimental procedure was to increase the stress by a discrete amount and then increase the current until the sample made a transition to the normal state. Copper-plated Nb_3Sn reached a maximum in critical current density at low values of stress. A maximum in the curve of critical current density against stress was observed when the ribbon was oriented transversely to the magnetic field with the field perpendicular to the ribbon surface. The maximum was typically 20 to 44% higher than the critical current density of the initially unstressed ribbon. The critical current density of all the other samples was nearly constant up to a value of stress slightly below the breaking point and then dropped off sharply. For all the samples tested, the changes in the critical current density with tension were irreversible. (auth)

5209 (UCRL-17159) EQUILIBRIUM PROPERTIES OF BOSON SYSTEMS AT LOW TEMPERATURES. Wong, Victor Kenneth (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 26, 1966. Contract W-7405-eng-48. 282p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A study of the equilibrium properties of boson systems at low temperatures with particular emphasis on the Bose–Einstein transition and restricted geometry is undertaken both from the microscopic and the macroscopic viewpoints. Use of the Green's function formulation enables the systematic study of essentially all microscopic models in the literature. In particular the zeroth-order approximation is the Ideal Bose gas, which is applied to the problem of restricted geometry. The first-order approximations include the Bogoliubov/Ideal, Hartree, Bogoliubov/Hartree, Hartree–Fock, and Bogoliubov/Hartree–Fock approximations. With the sole exception of the Hartree, the first-order approximations display a double-valued behavior in the number density and other thermodynamic functions. Application to restricted geometry results in the same problem as with the Ideal Bose gas, namely that the macroscopic occupation, i.e., the Bose–Einstein condensation, does not strictly appear in restricted geometry. The second-order approximations include the Belyaev/Hartree–Fock, Born-collision, Bogoliubov/Born-collision, Belyaev/Born-collision approximations. The Born-collision approximation is considered, and it is shown that it gives a logarithmic singularity to the specific heat in the Very Dense State limit. The Born-collision approximation is applied to restricted geometries by a variational technique. From the macroscopic viewpoint, it is shown that the Ginzburg–Pitaevskii theory can yield only second-order transitions in film geometries as well as in bulk systems. Based on symmetry considerations, a new, modified theory is proposed in which the order function is identified with the "anomalous" self-energy, which is motivated by a microscopic argument. The new theory is shown to agree with the experimental behavior of the superfluid mass density and the jump in the specific heat, to satisfy the exponent scaling laws, to give a third-order transition in film while giving a second-order in bulk, and to yield shifts in the transition temperature in agreement with experimental observations. (auth)

5210 (UCRL-70031) EXPERIMENTS WITH LARGE SUPERCONDUCTING SOLENOIDS. Taylor, Clyde (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 30, 1966. Contract W-7405-eng-48. 11p. (CONF-661016-28). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

Large superconducting coils with partial insulation between turns used to achieve a high current density are described. A summary is given of the performance of five different types of coils. (J.H.M.)

5211 DIRECT EVIDENCE OF PERSISTENT CURRENT LOOPS IN HARD SUPERCONDUCTING WIRE. Iwasa, Y.; Williams, J. E. C. (Massachusetts Inst. of Tech., Cambridge). Appl. Phys. Lett., 9: 391-2(Dec. 1, 1966).

Measurements of the field near the surface of a Nb–25% Zr superconducting wire magnetized by a static transverse field have revealed spatially periodic variations in local field strength indicative of persistent current loops ("macrovortices") about six wire diameters in size. (auth)

5212 A TIME-DEPENDENT GINZBURG–LANDAU EQUATION AND ITS APPLICATION TO THE PROBLEM OF RESISTIVITY IN THE MIXED STATE. Schmid, Albert (Technische Hochschule, Karlsruhe, Ger.). Phys. Kondens. Mater., 5: 302-17(1966).

A time-dependent modification of the Ginzburg–Landau equation is given which is based on the assumption that the functional derivative of the Ginzburg–Landau free energy expression with respect to the wave function is a generalized force in the sense of irreversible thermodynamics acting on the wave function. This equation implies an energy theorem, according to which the energy can be dissipated by production of Joule heat or irreversible variation of the wave function. The theory is a limiting case of the BCS theory, and hence, it contains no adjustable parameters. The application of the modified equation to the problem of resistivity in the mixed state reveals satisfactory agreement between experiment and theory for reduced temperatures higher than 0.6. (auth)

5213 SUPERCONDUCTING SWITCH. Huebener, R. P.; Govednik, R. E. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 37: 1675-6(Dec. 1966).

A superconducting switch is described which has an electrical resistance of 45 Ω in the nonsuperconducting state. The dimensions of the switch are 3.5 × 3.5 × 1.5 cm. (auth)

5214 ELECTRICAL AND THERMOMETRIC PROPERTIES OF SUPERIMPOSED LEAD-COPPER FILMS AT LOW TEMPERATURES. Grandison, J. M.; Walker, P. A.; Yates, B. Cryogenics, 6: 344-7(Dec. 1966).

Films of copper and lead have been vacuum deposited successively at room temperature, and their resistance–temperature characteristics have been explored in the range 1.6 to 4.2°K. Analysis of the results does not favor marked diffusion, but indicates rather the existence of a discrete layer structure, which displays a variation of the resistance characteristics depending upon the temperature of deposition. In common with earlier observations of the characteristics of sandwich films deposited at lower temperatures, and alloy films, a reduction of the lead content was observed to reduce the mean temperature of the transition region. The suitability of the films as thermometers in the approximate range 1 to 7°K is assessed, and a suggestion is made for extending the range of operation within these limits. (auth)

5215 THE USE OF LIQUID ^{3}He TO OBTAIN TEMPERATURES DOWN TO 0.3 DEG K. Shvets, A. D. Cryogenics, 6: 333-7(Dec. 1966).

Until recently, temperatures below 0.7°K were obtained by the magnetic cooling method. The use of liquid ^{3}He has provided a simple way of reaching temperatures down to 0.3°K. All the cryostats and methods of reducing the vapor pressure of liquid ^{3}He which have been described, enabling the temperatures quoted to be reached, are reviewed. (auth)

5216 SUPERCONDUCTING MAGNET DEVELOPMENTS. CONCLUSION. Laverick, Charles. Argonne Nat. Lab. Rev., 3: 80-6(July 1966).

Some magnets of significance to the development of superconducting magnet technology are discussed briefly and a present state of the art is indicated rather than a complete listing of current achievements. Test facilities and instrumentation are described and the economics of superconducting magnets are discussed. Large bubble chamber magnet studies, coil fabrication facilities, and future developments are mentioned. (W.D.M.)

5217 NEW METHOD FOR MEASURING THE SPEED OF FLUX JUMPS IN TYPE-II SUPERCONDUCTORS. Keyston, J. R.; Wortheimer, M. R. Cryogenics, 6: 341-3(Dec. 1966).

The use of a cryostat with two sets of windows enables disc-shaped specimens of type-II superconducting material to be observed from both sides. The electronic detector described incorporates a photomultiplier tube used to measure the speed of flux jumps, while a conventional 16-mm camera films the events on the other face of the specimen. (auth)

5218 ADJUSTABLE TEMPERATURE CRYOSTAT FOR OPTICAL STUDIES. Benarroche, M.; Danoy, J. P.; Pesteil, P. Cryogenics, 6: 330-2(Dec. 1966).

A liquid hydrogen cryostat with temperature adjustment between 20 and 100°K is described. Replacement of the hydrogen by liquid helium or liquid nitrogen extends the range of accessible temperatures from 4 to 150°K. This cryostat is suitable for both optical absorption and luminescence studies and can be easily adapted for photoelectric work (electroluminescence, photoconductivity, etc.). (auth)

5219 ION MOTION IN LIQUID HELIUM. Mazzoldi, P. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (1), 3: Suppl., 640-50(1965). (In Italian).

A synthetic picture is given of the results obtained and the problems encountered in the study of the motion of electrical charges (ions) in liquid He II. The heat flush experiment to determine if low-velocity ions interact only with the normal fluid is described. Studies made on intrinsic phenomena of He and on the properties of the ion–He complex are outlined and the results are summarized. The ion mobility under imposed magnetic field is shown. The hydrodynamic regime was divided into three distinct zones, each of which is considered in some detail. (J.S.R.)

5220 A TAIL-DEWAR FOR LIQUID HELIUM. Kroon, D. J. (Philips Research Labs., Eindhoven, Netherlands). J. Sci. Instrum., 43: 831(Nov. 1966).

Description and constructional details are presented of a sealed-off glass tail-Dewar for liquid helium with conduction cooled metallic radiation screen in the Dewar tail. The difference thus obtained between inner and outer diameter of the Dewar tail is only 10 mm. (auth)

5221 CHARGE TRAPPING BY A VORTEX LINE IN SUPERFLUID HELIUM. Soda, Toshio (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 435-44(Sept. 1966).

A mechanism for the trapping of charged helium ions by a vortex line in liquid ^{4}He was investigated, assuming a short-range repulsive helium-ion interaction and a long-range polarization force on the helium atoms. The upper bound for the effective mass of the ion to be trapped by the vortex line for a given value of the ion radius and the lower bound of the ion radius for a given value of the effective mass of the ion were obtained. From this a qualitative explanation of the fact that only negative ions are trapped in vortex lines in rotating liquid ^{4}He and of how a positive ion may be trapped as well as a negative ion in the case of a vortex ring is suggested. (auth)

5222 NOTE ON ROTATING He II ACCORDING TO THE THEORY OF GINZBURG-PITAEVSKII. Falk, G.; Stenschke, H. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 197: 505-8(1966).

The Ginzburg–Pitaevskii theory of He(II) is applied to He(II) within a rotating annulus. The results agree with corresponding results, obtained by Douglass, for a superconducting annulus in a magnetic field. Although the credit for having treated the subject first goes to Bennett and Falicov, their results are, due to the use of a wrong thermodynamic potential, partly incorrect. (auth)

5223 SOME PROPERTIES OF QUANTIZED VORTEX RINGS NEAR A WALL IN SUPERFLUID HELIUM. Soda, Toshio (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 36: 445-53(Sept. 1966).

The behavior of a quantized vortex ring near a wall is investigated. It is shown that, because of frictional forces due to quasiparticle collisions, the free vortex rings move slower and their radii are diminished. The influence on rings near a wall is such as to stop them at a closer distance to the wall. It is also shown that the ring stops in front of a wall in a quite stable way. How the rings behave in an ac field is considered. (auth)

5224 THE INFLUENCE OF ^{3}He ON THE LAMBDA TEMPERATURE. Kapadnis, D. G. (Rajaram Coll., Kolhapur, India). Indian J. Phys., 40: 355-61(June 1966).

The observed change in the lambda transformation temperature with the concentration of ^{3}He in ^{4}He gives for low concentrations a negative linear shift of 1.48 degrees per mole concentration. The lambda transition is of the second order and there seems to be no appreciable change in the jump in the specific heat at the lambda point. (auth)

5225 GAPLESS SUPERCONDUCTIVITY IN DIRTY ALLOYS IN A MAGNETIC FIELD. Guyon, Etienne (Univ., Paris, Orsay, France). Advances Phys., 15: 417-90(July 1966). (In French).

Gapless superconductivity (SSBI) is studied by tunnelling experiments on "dirty" superconducting alloys in high magnetic field. The existence of a pair potential $\Delta(r) \neq 0$ does not imply necessarily that of an energy gap in the excitation spectrum. A situation of SSBI was first expected in the case of superconductors containing magnetic impurities. Both examples are characterized by an anti-symmetric magnetic interaction which acts with opposite signs on the electrons of a Cooper pair. In the limiting case where Δ is small, this superconductivity takes a simple form predicted by de Gennes. A theoretical description is given of it. The main results are: (1) the density of states $N(E)/N_0$ only depends on an energy $\hbar/\tau$ (related to the antisymmetric interaction) which is a universal function of the temperature; (2) $N(E)/N_0$, at a point r, is proportional to $\Delta(r)$, which controls the amplitude of residual effects near the upper critical field, H_{max} ($\Delta \rightarrow 0$ for $H \rightarrow H_{max}$). The experiments confirm these predictions: (1) in a field range extending down to 0.7 H_{max} an SSBI is observed in excellent agreement with the theoretical form, it is not possible to describe the field behavior with an effective gap model (the gap Δ being a function of the field); and (2) the amplitude of the deviation between the superconducting and normal characteristics gives a measurement of the average of $\Delta(r)$ on the junction surface, in the case of a field perpendicular or parallel to it where one has either vortex lines or surface superconductivity effects, and the results are in good agreement with other measurements based on macroscopic magnetization. The determination of the excitation by tunnelling may help to interpret many other properties of second-kind superconducting materials in a magnetic field (specific heat, dissipative effects). (tr-auth)

5226 SUPERCONDUCTIVITY OF ALPHA URANIUM. Howlett, B. W. (Atomic Energy Research Establishment, Harwell, Eng.). Science, 154: 542-3(Oct. 28, 1966).

Matthias suggested (Science, 151: 985(1966)) that the superconducting behavior of α uranium may be due only to superconducting filaments of retained stabilized α, β, and γ phases, or perhaps even filaments of superconducting compounds. This suggestion is discussed point by point, and it is concluded that the apparent superconductivity of α uranium does not seem to be explainable on this basis. Matthias, in an appended comment, defends his original suggestion. (W.D.M.)

5227 THERMODYNAMICAL BEHAVIOR OF TYPE-II SUPERCONDUCTORS WITH SMALL κ NEAR THE LOWER CRITICAL FIELD. Kramer, L. (Univ., Hamburg). Phys. Lett., 23: 619-20(Dec. 12, 1966).

The interaction between well-separated Abrikosov vortices is calculated for superconductors with $\kappa < \sqrt{2}$. For $\kappa > 1/\sqrt{2}$ a λ transition takes place at H_{c1}, changing into a first order transition as $\kappa \rightarrow 1/\sqrt{2}$. (auth)

5228 TUNNEL EFFECT BETWEEN SUPERCONDUCTORS IN AN ALTERNATING FIELD. Larkin, A. I.; Ovchinnikov, Yu. N. Zh. Eksp. Teor. Fiz., 51: 1535-43(Nov. 1966). (In Russian).

An expression for the Josephson current is obtained which is not based on the assumption that the voltage applied to the contact is small and varies at a slow rate. Various limiting cases are considered. (auth)

5229 PROPAGATION OF FOURTH SOUND IN HELIUM NEAR THE λ POINT. Sanikidze, D. G. Zh. Eksp. Teor. Fiz., 51: 1550-6(Nov. 1966). (In Russian).

Hydrodynamic equations of a superfluid liquid in which the relaxation ρ_s near the λ point is taken into account are derived under the assumption that the normal component of the helium velocity $v_n = 0$. The fourth sound velocity and absorption coefficient related to the relaxation ρ_s are calculated. (auth)

5230 SUPERCONDUCTING INDIUM ANTIMONIDE. Minomura, S.; Okai, B.; Onoda, Y.; Tanuma, S. (Tokyo Univ.). Phys. Lett., 23: 641-2(Dec. 12, 1966).

The superconducting transition temperature in quenched metallic indium antimonide depends on the treating pressure and temperature. It increases from 1.6 to 5.1°K with increasing pressure and decreasing temperature. It is associated with the density of states of electrons. (auth)

5231 X-RAY STRUCTURAL INVESTIGATIONS OF SUPERCONDUCTING ALLOYS WITH NIOBIUM AS THE BASE. Kogan, V. S.; Lazarev, B. G.; Yakimenko, L. F. Zh. Eksp. Teor. Fiz., 51: 1328-31(Nov. 1966). (In Russian).

A number of niobium–zirconium–titanium ternary alloys containing from 5 to 50 wt % zirconium and 10 to 20 wt % titanium are investigated. In the original cast state all of the investigated alloys possess a structure of the hardened cubic phase. The samples were also investigated after vacuum annealing at 350 to 600°C. Concentration intervals of the existence of two-phase regions and the compositions corresponding to extreme solid solutions of zirconium in the β-solid niobium–titanium solution and of niobium in the α-solid zirconium–titanium solution are found on the low-temperature (below 600°C) isothermal cross sections of the triple diagram. Some details of the kinetics of decay of supersaturated solid solutions during annealing are elucidated. (auth)

5232 CONDENSATION OF ROTATING HELIUM II. Bablidze, R. A.; Gavrilidi, N. S. Zh. Eksp. Teor. Fiz., 51: 1341-3(Nov. 1966). (In Russian).

The velocity of first sound in rotating helium II is measured at temperatures T = 1.40 to 2.10°K and angular velocities $\omega = 0$ to 70 $\sec^{-1}$. It is shown that the compressibility of liquid helium does not depend on the rotation velocity. (auth)

5233 CONDENSATION OF ROTATING HELIUM II AND THE DENSITY JUMP AT THE PHASE TRANSFORMATION POINT. Andronikashvili, E. L.; Tsakadze, Dzh. S. Zh. Eksp. Teor. Fiz., 51: 1344-7(Nov. 1966). (In Russian).

It is demonstrated that a density jump (discontinuity of first derivative of Gibbs free energy function) occurs at the helium II–helium I phase transformation point under conditions of rotation. (auth)

5234 ELECTRODYNAMICS OF THE INTERMEDIATE STATE. Andreev, A. F. Zh. Eksp. Teor. Fiz., 51: 1510-21 (Nov. 1966). (In Russian).

A complete set of electrodynamic equations averaged over volumes with dimensions considerably exceeding the layer thickness is derived for the intermediate state of a superconductor of the first kind at low temperatures. The direct current resistance is determined by means of the equations, the effect of the current magnetic field on the intermediate-state structure being taken into account. It is shown that electromagnetic waves similar to normal metal helicons may be propagated in the intermediate state of superconductors with unequal numbers of electrons and holes. The surface impedance of the intermediate state in a varying external field is calculated. (auth)

5235 MAGNETIZATION IN IDEAL BOSE SYSTEMS. Smith, E. R.; Frankel, N. E. (Univ. of Melbourne). Phys. Lett., 23: 660-1(Dec. 12, 1966).

The magnetization of a charged ideal "pair gas" is shown to resemble that of a superconducting ferromagnet. (auth)

Plasma and Thermonuclear Physics

Confinement and Heating of Plasma

Refer also to abstract 5437.

5236 (IPP–1/51) PLASMADYNAMIK BEI HOCHFREQUENTEN THETA-PINCH ENTLADUNGEN. (Dynamics of a Plasma in a High Frequency Theta Pinch Discharge). Decker, Gernot (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Sept. 1966. 44p. (In German). Dep. mn.

Some experiments are described, in which the magnetic field of the theta-pinch discharge oscillates with a frequency of about 1 Mc. The amplitude of the magnetic field (some kΓ) and the filling pressure of the gas ($\approx$0.1 torr) are such that the compression and oscillation times of the produced plasma are roughly of the same magnitude as the half period of the magnetic field. These conditions may arise during the preionization of a gas by a theta-pinch discharge. It is found that a dynamic confinement of the plasma may be achieved if filling pressure, frequency, and amplitude of the magnetic field are properly chosen. Otherwise, the plasma will heavily touch the walls and impurities will be introduced into the plasma. Three models are applied to get a description of the plasma dynamics: the snow-plough model shows how the compression velocities depend on the discharge parameters; another simple model is applied to obtain the oscillations of a plasma column in a high-frequency magnetic field; and finally, some experimental results are compared with the solutions of a magnetohydrodynamic three-fluid model. (auth)

5237 (NP–16389) INERTIAL EFFECTS IN THE DIFFUSION OF A PLASMA ACROSS A MAGNETIC FIELD. Rijnhuizen Report 66-31. Gerwin, R. A. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Sept. 1966. 184p. Dep. mn.

A column of ionized gas, infinitely long, immersed in a magnetic field parallel to the column axis is considered. The diffusion of the plasma across the magnetic field is studied theoretically. Two cases are considered, namely, that of a time-independent magnetic field, and that in which the magnetic field has a time-dependent part. In the case of a steady magnetic field, the Bohm criterion for a sheath, previously invoked without much justification in some plasma diffusion problems, is derived under fairly general conditions, including cylindrical geometry, production and collisions of charged particles, and slightly and strongly ionized plasmas. In this derivation, it is essential to retain the usually neglected ion inertial terms in the ion momentum-balance equation. When the magnetic field has a part with a periodic time dependence, it is shown that, under certain conditions, ion inertia rather than pressure gradients can cause the plasma to diffuse across the magnetic field towards the walls. The theory suggests that this diffusion mechanism, and also Ohmic heating, can become significant when the amplitude of the alternating magnetic field approaches the level of the steady magnetic field. (auth)

5238 (SIT–2582-20) ON THE CALCULATION, CONSTRUCTION AND MEASUREMENT OF PULSED MAGNETIC FIELDS FOR CHALICE. Harvey, R.; Yevick, G.; von Voros, G. (Stevens Inst. of Tech., Hoboken, N. J.). [nd]. Contract AT(30-1)-2582. 19p. (CONF-661016–30). DTIE.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

A numerical relaxation method is described for calculating high-frequency-pulsed-magnetic field configurations of axial symmetry using the accurate simplification of vanishingly small skin depth. Some useful rule-of-thumb concepts which result are noted. A not-so-well known variational method for calculating an upper and lower bound for the self and mutual inductances of a pulsed coil is presented. This calculation is based upon the minimization of magnetic field energy. The construction of high strength and complexly shaped field coils featuring low resistance and minimum distortion from feedins for use on CHALICE is described. Experimental field mapping and monitoring methods are also described. (auth)

5239 (SIT–2582-21) ENGINEERING DEVELOPMENTS IN THE CHALICE EXPERIMENT. Yevick, George J.; von Voros, Geza; Harvey, Robin; Martellucci, Sergio; Waly, Adnan; Opat, Henry; Nyland, Harry (Stevens Inst. of Tech., Hoboken, N. J.). [1966]. Contract AT(30-1)-2582. 13p. (CONF-661016-31). DTIE.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

The Chalice experiment utilizes two fast θ pinches to generate hot plasma which in turn is fed into a cusp region formed by the θ-pinch coils. The 64-μf main bank is very fast, having a rise time of 1 μsec. A 20-kV, 135-μf bank with a rise time of around 8 μsec now forms an integral part of the Chalice experiment. A second major engineering development in Chalice has been a new preheating mechanism, the efficacy of which still has to be measured carefully. Diagnostic equipment includes a fast neutron scintillator counter, neutron detectors, Mach–Zehnder interferometer, image converter for streaking of line spectra, and a monochromator. Some typical experimental results are presented. (M.O.W.)

5240 (TID-23454) TECHNICAL PROGRESS REPORT [ON PLASMA PHYSICS] FOR THE YEAR FEBRUARY 1, 1966–JANUARY 31, 1967. (Wisconsin Univ., Madison). Contract AT(11-1)-1233. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Research progress on plasma anomalous diffusion experiments in toroidal octupole magnetic fields is discussed. Oscillations, techniques, and equipment are briefly discussed. (M.O.W.)

5241 (UCRL-70023) SUPERCONDUCTING COILS FOR BASEBALL-TYPE MINIMUM-B FIELDS. Taylor, Clyde (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 30, 1966. Contract W-7405-eng-48. 10p. (CONF-661016-27). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

The "baseball" coil for producing "minimum B" magnetic fields is described. The magnetic force distribution on the coil is shown. Diagrams of the apparatus are given. (M.O.W.)

5242 NEW TARGETS IN FUSION RESEARCH. Stubbs, Peter. New Sci., 32: 518-20(Dec. 1, 1966).

A review is presented of the research devices in the United Kingdom for plasma confinement and stabilization. Magnetic well type devices are briefly discussed. (M.O.W.)

5243 INVESTIGATION OF A SYSTEM WITH A TOROIDAL MAGNETIC FIELD INCREASING TOWARD THE PERIPHERY (THE "TORNADO" TRAP). Abramova, K. B.; Galechyan, G. A.; Peregud, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1426-34(Aug. 1966). (In Russian).

The magnetic fields produced by helical wound conductors were investigated. The investigations were undertaken in an effort to realize with ordinary conductors the fields having toroidal topology and containing an inner region of low field strength which was earlier shown to be possible within a superconducting sphere. The device consisted of an 18.5 cm diameter copper spherical shell of 8-mm wall thickness containing a 14-turn helix of 8-mm-diameter Armco iron rod separated from the copper shell by a 1-cm gap. The fields within the devices under low frequency excitation were mapped with probes. In the devices of both types the central region was separated from all the conductors by regions of enhanced field strength. The time during which a high strength field can be maintained depends on the inertia of the inner helical winding, which ultimately collapses under electrodynamic forces. The inner helix resisted collapse for 5 to 8 milliseconds under currents that produced a maximum field strength of about 20 kOe. (ATD)

5244 SPREADING AND SHAPE OF INHOMOGENEITIES IN A PLASMA. Gurevich, A. V.; Tsedilina, E. E. (Lebedev Inst. of Physics, Moscow. Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 200-8(1966).

Translated from Geomagn. Aeronomiya, 6: 255-65(1966).

The spreading in a magnetic field in plasma of inhomogeneities with dimensions much larger than the mean free path of a particle is analyzed. It is shown that in the absence of drift, disturbances in particle concentration in an inhomogeneity decrease with time in proportion to $1/t^{1/2}$, as in ordinary diffusion. The shape of an inhomogeneity, however, is quite other than ellipsoidal. The asymptotic behavior of concentration disturbances changes qualitatively at great distances: as r increases, they decrease only according to the power law $\delta N \sim 1/r^5$ and not the exponential law $\delta N \sim \exp\{-r^2/4Dt\}$, characteristic for ordinary diffusion. The rate of movement of an inhomogeneity across a magnetic field exceeds by many times the rate of transverse electron diffusion. It is shown that in the presence of charged-particle drift in the plasma, the spreading of inhomogeneities is no longer of a diffusive nature. An important role is played by a new "dispersion" mechanism of spreading. Concentration disturbances decrease in proportion to $1/t^2$ and in one direction, in proportion to $1/t^{1/2}$. The inhomogeneity is strongly elongated in a direction which does not coincide with the direction of the magnetic field in the plasma. The ratio of the longitudinal to the transverse dimension of an inhomogeneity increases with time in proportion to $\sqrt{t}$. (auth)

Diagnostics of Plasma

Refer also to abstracts 4689, 5284, and 5304.

5245 (IPP-1/48) LICHTSTREUUNG UND DRIFTINSTABILITAET IN EINEM PLASMA. (Light Scattering and Drift Instability in a Plasma). Theimer, Otto (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). July 1966. 67p. (In German). Dep. mn.

A review of the light scattering theory and a discussion of light scattering as a tool for plasma diagnostics are presented. The effect of an electron drift relative to the ions is discussed in great detail, and criteria for the occurrence of drift instabilities are derived from the scattering theory. A quantitative analysis of these criteria is presented, and it is indicated how light scattering could be used for a study of collisionless heating processes by which the ordered energy of drift excited plasma waves is thermalized. A review is presented of the theory of longitudinal plasma waves, including light scattering theory, dispersion theory, and the theory of drift instabilities. Mathematical developments are presented in simple form and great detail and no use is made of the theory of complex functions. Instability criteria are derived from the dispersion theory which are not fully consistent with those obtained from the scattering theory, and suggestions are made how the discrepancies could be removed. (auth)

5246 (SC-DC-66-2267) NONEQUILIBRIUM ELECTRON TEMPERATURE MEASUREMENTS IN A SUPERSONIC ARC JET USING A COOLED LANGMUIR PROBE. Johnson, D. H. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1966. Contract AT(29-1)-789. 28p. (CONF-660940-2). DTIE.

From 26th Supersonic Tunnel Association Meeting, Moffett Field, Calif.

A cooled Langmuir probe was developed and used to measure the stagnation point electron temperature in the exhaust of a supersonic arc jet. The electron temperature measured with the probe was consistently greater than that obtained by an energy balance technique. In order to explain this difference, it is hypothesized that the stagnation of a supersonic preionized gas gives rise to nonequilibrium effects. (auth)

5247 NEW DEVICE FOR THE AUTOMATIC PLOTTING OF THE TRAJECTORIES OF CHARGED PARTICLES IN AN ELECTROSTATIC FIELD. Tenchov, H.; Stainov, G.; Vitkov, A.; Roussev, R. (Inst. of Physics, Academy of Sciences, Bulgaria). Compt. Rend. Acad. Bulg. Sci., 19: 475-8(1966).

The devices described for automatic plotting of the trajectories of charged particles in a given electrostatic field are combinations of apparatuses for modeling the field and computers. The structures referred to are based on Newton's equations, the intensity of the field being measured with triple quadruple probes. The technique is described. (M.O.W.)

5248 MICROWAVE SCATTERING FROM AN UNDERDENSE TURBULENT PLASMA. Guthart, H.; Weissman, D. E.; Morita, T. (Stanford Research Inst., Menlo Park, Calif.). Radio Sci., 1: 1253-62(Nov. 1966).

The bistatic radar cross section of an underdense, inhomogeneous turbulent plasma was measured and the results were compared with a theoretical model. The turbulent plasma was formed by seeding a premixed ethylene–oxygen flame in a combustion chamber and exhausting it through an expansion nozzle into a low-pressure vessel. Electrostatic probes, biased for ion collection, were used to map the variation of the mean and rms electron density throughout the turbulent regions and to measure the correlation coefficient of the plasma fluctuations. A theoretical scattering model was constructed using the Born approximation and the results of the diagnostic measurement program. Good agreement between theory and experiment was obtained for the dependence of cross section on bistatic angle and for the spectrum of fluctuations of the scattered microwave signal. The predicted cross section underestimates the measured cross section by 6 to 11 dB when the measured cross sections are in the range from 10^{-6} to 10^{-5} m^2. The measured cross section was observed to have a square-law dependence on electron density in agreement with the Born model for densities up to 1% of the critical electron density. For densities beyond this, the Born approximation breaks down and the cross-section dependence becomes linear. (auth)

5249 STRUCTURE OF THE DISTURBED ZONE IN THE VICINITY OF A CYLINDRICAL BODY IN PLASMA. Moskalenko, A. M. (Inst. of Terrestrial Magnetism, Ionosphere, and

Radio Wave Propagation, Academy of Sciences, USSR). Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 209-17(1966).

Translated from Geomagn. Aeronomiya, 6: 266-75(1966).

Disturbances produced by a long cylinder of large radius at rest in a plasma are analyzed on the basis of kinetic theory. Relations are found between the electric field, electron and ion concentrations, and distance for various field potentials at the surface of the body. The flux of electrons and ions per unit length of the cylinder surface is computed and probe characteristics are constructed. The results of numerical computations are presented. (auth)

5250 INTERPRETATION OF PLASMA MEASUREMENTS IN A WAVEGUIDE INTERACTOMETER. Kaliszewski, T. (Adcom, Inc., Cambridge, Mass.). Int. J. Electron., 21: 1-16(July 1966).

A variant of a waveguide method of measuring plasma parameters, known as an interactometer, is considered with a view of exploring its capabilities. Its operation is interpreted by a set of simple relations linking observables with the principal parameters of plasma and of the measuring system. In deriving these relations use is made of certain results from the theory of electromagnetic wave propagation in plasma-filled waveguides and from the semi-linear theory of wave interaction. It is concluded that an interactometer constitutes a feasible configuration of a conventional method particularly useful in investigations demanding high time resolution. Measurements in an interactometer are essentially free from the perturbations introduced by a dielectric plasma container. Its use in the determination of the fractional electron energy loss factor G appears to be especially attractive inasmuch as it is distinguished by simplicity and economy of means. (auth)

5251 THEORY OF A HOT PROBE AND A PHOTOSONDE. Smirnova, V. V. Geomagn. Aeronomy (USSR) (Engl. Transl.), 6: 218-24(1966).

Translated from Geomagn. Aeronomiya, 6: 276-83(1966).

A heated body in a plasma is analyzed and the potential arising on the body is determined as a function of the temperature of its surface and of plasma characteristics. The current on the body is computed as a function of its potential, temperature, and plasma parameters with allowance for thermal emission. Formulas are obtained for determining the potential arising on the body in plasma in the presence of photoemission. (auth)

5252 TEMPERATURE IN SPACE AND TIME IN THE PLASMA OF A TRANSIENT ELECTRIC DISCHARGE. Bardocz, A.; Voeroes, T. (Univ. for Technical Sciences, Budapest). J. Quant. Spectros. Radiative Transfer, 6: 775-85(Nov.-Dec. 1966).

The time and space dependence of the temperature in a cylindrically symmetric, transient plasma was determined. An analytical method is given for the calculation of the relative intensities of spectral lines as functions of the discharge channel temperature on the axis for a cylindrically symmetric transient plasma. Time-resolved spectroscopic observations were made in this work. Using the calculated and normalized intensity curves as functions of channel axis temperature, and the measured and normalized intensity curves as functions of time, the temperature on the channel axis of a transient plasma was determined. The radial distribution of the temperature perpendicular to the axis of the plasma, at different times, was then calculated. (auth)

5253 CONTINUUM RADIATION OF OXYGEN AND NITROGEN FOR USE IN PLASMA TEMPERATURE DETERMINATION. Morris, J. C.; Krey, R. U.; Bach, G. R. (Avco Corp., Wilmington, Mass.). Contract AF 33(615)-2976. J. Quant. Spectros. Radiative Transfer, 6: 727-40(Nov.-Dec. 1966).

The temperature dependence of the continuum radiation from 9000°K to 14,000°K of oxygen and nitrogen at 4348 and 4955 Å respectively was measured with sufficient accuracy to permit it to be used as a convenient and accurate means of measuring plasma temperatures. These data were analytically treated to separate the continuum into the contribution of electron–neutral and electron–positive ion radiative processes and were compared with and found to be in satisfactory agreement with recent theoretical estimates. Based upon this agreement, tables were constructed for the temperature dependence of the continuum radiation of oxygen and nitrogen from 9,000 to 18,000°K and for pressures ranging from 0.1 to 5.0 atm. (auth)

5254 SPECTROSCOPIC INVESTIGATION OF A HELIUM PLASMA ARC. Bott, J. F. (Harvard Univ., Cambridge, Mass.). J. Quant. Spectros. Radiative Transfer, 6: 807-22(Nov.-Dec. 1966).

The spectral line radiation from the Poiseuille plasma arc, operated at 100 A and 1 atm pressure in helium, was investigated. The purpose was to determine whether the state of the plasma can be described as being in local thermodynamic equilibrium with a single temperature or whether additional parameters are needed to describe the state of the plasma. The emission coefficients of six helium lines were measured and these results compared to measurements of the Stark broadening of a line. (auth)

5255 COMPUTED PROFILES FOR ELECTROMAGNETIC RADIATION SCATTERED FROM A PLASMA. Williamson, J. H.; Nodwell, R. A.; Barnard, A. J. (Univ. of British Columbia, Vancouver). J. Quant. Spectros. Radiative Transfer, 6: 895-8(Nov.-Dec. 1966).

Cross sections were computed for the scattering of monochromatic radiation incident on a plasma. The results are summarized in a series of figures showing scattering profiles for typical laboratory plasmas. For very diffuse plasmas the profiles are nearly Gaussian and for more dense plasmas the profiles show the central maximum and the two satellite peaks predicted by previous investigators. The profiles can show a sharp minimum when the frequency shift is close to the ion plasma frequency. (auth)

5256 PROPAGATION CONSTANT FOR WAVES IN A RECTANGULAR WAVEGUIDE CONTAINING A DIELECTRIC TUBE FILLED WITH PLASMA. Ponomarev, V. N.; Solntsev, G. S. (Moscow State Univ.). Zh. Tekh. Fiz., 36: 1376-82(Aug. 1966). (In Russian).

The propagation constant is calculated for H_{01} waves of a rectangular waveguide containing a hollow dielectric cylinder filled with a plasma whose density is such that the Langmuir frequency of the plasma is of the order of the frequency of the waves. The calculations were undertaken because of their possible applications in plasma diagnostics. It is assumed that the circumference of the dielectric cylinder is small compared with the wavelength, and the plasma is described by an expression for its complex dielectric constant that contains the Langmuir frequency and the electron collision frequency. The effect of the dielectric wall of the tube is calculated, and the final expressions for the real and imaginary parts of the propagation constant are given in a form suitable for direct application to plasma diagnostics. The propagation constant exhibits resonance behavior at a frequency close to the Langmuir frequency of the plasma (the resonance frequency is shifted slightly by the presence of the dielectric wall of the tube). Other experiments on confined plasmas in waveguides are discussed briefly and are interpreted with the aid of the derived equations. (ATD)

5257 MILLIMETER AND SUBMILLIMETER WAVELENGTH INTERFERENCE FILTERS FOR INVESTIGATION OF PLASMA RADIATIONS. Balakhanov, V. Ya.; Rusanov, V. D.; Striganov, A. R. Zh. Tekh. Fiz., 36: 1383-6(Aug. 1966). (In Russian).

A Fabry–Perot interferometer was discussed earlier for millimeter and submillimeter wavelengths, each of the two mirrors of which consists of a number of parallel metal film bands on a Plexiglas or fused quartz substrate. An interferometer is described here in which two such mirrors are mounted with their planes parallel but with their respective metallic bands perpendicular to each other ("crossed Fabry–Perot interferometer"). The theory of the crossed interferometer is developed, and it is shown that the instrument can serve as a band pass filter. Such a crossed interference filter, designed for a wavelength of 8.4 mm, was constructed and tested. The mirrors were deposited on in a 9.5 cm diameter circle on 1.05 cm thick Plexiglas substrates. The filter passed 80% of the incident 8.4 mm radiation with a Q factor of 10, and passed less than 1% of the incident 4-mm radiation. It is proposed that such crossed Fabry–Perot interference filters be employed to investigate the electromagnetic radiations of plasmas. (ATD)

5258 HIGH-SENSITIVITY SCHLIEREN TECHNIQUE. Hall, Laurence S. (Univ. of California, Livermore). Rev. Sci. Instrum., 37: 1735-6(Dec. 1966). (UCRL-14813).

The use of a multipass system of high sensitivity is proposed, which should be capable of extending the schlieren technique to plasma densities two orders of magnitude less than is possible with conventional systems. The modification has similar application to shadowgraph techniques. (M.H.R.)

5259 USE OF ROTATING LANGMUIR PROBES IN FLOWING PLASMAS. Brooks, David R. (Langley Research Center, Hampton, Va.). Rev. Sci. Instrum., 37: 1731-2(Dec. 1966).

To determine the distribution of flow velocities in a highly ionized supersonic, low-density MPD arc, Langmuir probes are used. It is demonstrated that a rotating probe should be used to give reliable flow velocity data within the limitations of probe theory. (M.H.R.)

5260 TEMPERATURE OF CHARGED PARTICLES IN THE HIGH ATMOSPHERE. Mariani, F. (Univ., Rome). Nuovo Cimento (1), 3: Suppl., 706-25(1965). (In Italian).

The experimental methods used in the measurement of the temperature of charged particles in the high atmosphere are illustrated. The results obtained are discussed and interpreted. The problems encountered are shown and some indication is given of the research needed in future years. (J.S.R.)

5261 LIGHT SCATTERING IN PLASMA. Katzenstein, J. (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (1), 3: Suppl., 676-87(1965).

Scattering of laser light by a θ-pinch plasma was measured. The experimental arrangement is described. The scattered spectra obtained at low and high resolution are given. The results showed that, in accordance with theory, the spectra of the scattered light are narrow. In the high-resolution spectrum the scattered light is displaced in wave lengths toward the short-wavelength side of the central lines as would be expected if there were an inward shift of radioelectrons with respect to ions. The results showed that it is possible to use the scattering of a laser beam as a diagnostic tool in laboratory plasmas. (J.S.R.)

Kinetics of Plasma

Refer also to abstracts 5236 and 5247.

5262 (AD-629685) SINGULAR SOLUTIONS OF CERTAIN INTEGRAL EQUATIONS. Research Paper. Case, Kenneth M. (Institute for Defense Analysis, Arlington, Va. Jason Div.). Jan. 1966. Contract SD-50. 46p. (RP-P-240; IDA-HQ-66-4533). CFSTI $4.60 cy, $0.50 mn.

A class of integral equations arising in some idealized plasma problems is discussed. While these do not have solutions in the space of square integrable functions, they do have such in an appropriate space of generalized functions. Explicit solutions are given in some special cases. It is then shown how these solutions can be used to approximate those for more general problems. (auth)

5263 (AD-637494) IONIZING FRONTS IN PLASMA PROPULSION AND POWER GENERATION SYSTEMS. Final Report. Rosciszewski, Jan (General Dynamics/Convair, San Diego, Calif. Space Sciences Lab.). May 2, 1966. Contract AF 49-(638)-1556. 11p. (AFOSR-66-1178). CFSTI $3.00 cy, $0.65 mn.

The program incorporates two major items: (a) study of the efficiency of different systems of plasma propulsion devices together with a discussion of the physical phenomena associated with the energy transformation losses; (b) study of the physical parameters associated with the plasma flow such as the effect of current density resulting from ionization in a magnetic field. Other items are the influence of radiation on ionization behind a shock wave, the structure of the rarefaction discharge layer, and others. In addition, the feasibility of a new type of power generator and a nuclear rocket was investigated. (auth)

5264 (AD-637581) ACCELERATION PROCESS IN THE HALL CURRENT DEVICE. Rosciszewski, Jan (General Dynamics/Convair, San Diego, Calif. Space Sciences Lab.). June 1966. Contract AF 49(638)-1556. 19p. (AFOSR-66-1421). CFSTI $3.00 cy, $0.65 mn.

A simplified analytical model of the flow process in a Hall current accelerator device is discussed. The initial acceleration from subsonic to sonic velocity (due to both Joule heating and a Lorentz force resulting from an ionizing current effect) leads to plasma temperatures and degrees of ionization of the same order of magnitude as those obtained from experiments. Examination of the expansion of the plasma in the magnetic nozzle shows that the energy of azimuthal motion of the plasma is transformed into axial directed energy. For hydrogen the final exhaust plasma velocity is about 100,000 m/sec. (auth)

5265 (AD-637587) INCOHERENT RADIATION PROCESSES IN PLASMAS. Hinton, Fred L. (California Inst. of Tech., Pasadena). Aug. 1966. Contract AF 49(638)-1462. 60p. (TR-4). CFSTI $3.00 cy, $0.65 mn.

The power spectrum of the microscopic density fluctuations in a plasma is calculated using an approximate solution of the n-particle problem. This solution makes use of the assumption that the particle trajectories, in a homogeneous plasma with many particles per Debye sphere, are nearly straight lines for large time intervals, and particle interactions can be treated as small perturbations. The general problem of radiation in such a plasma is formulated in terms of a wave equation which describes the refractive index property of the plasma, and whose source term is a sum of terms responsible for the absorption and the scattering of microscopic wave, and for bremsstrahlung. The spectral flux density and emissivity for the scattered radiation and the bremsstrahlung are related to the power spectra of the microscopic density fluctuations. The source term responsible for absorption is calculated, using a generalization of the solution of the n-particle problem. The physics of the various processes are clarified by deriving them from basic principles, and not using the formalism of plasma kinetic theory. (auth)

5266 (FTI-270/P-057) K VOPROSY OB ADIABATICHNOSTI DVIZHENIYA PLAZMENNYKH SGUSTKOV V PRODOL'NOM MAGNITNOM POLE. (Adiabatic Motion of Plasma Bursts in a Longitudinal Magnetic Field). Khizhnyak, N. A.; Kalmykov, A. A.; Trubchaninov, S. A.; Haboka, V. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1965. 20p. (In Russian). Dep. mn.

Theoretical and experimental investigations were made on the mechanism of introduction of small plasma bursts into an axially symmetric magnetic field as a function of the particle density within the burst. All theoretical results are obtained in the general flexible current loop model approximation allowing a transition either to the single particle or to the magnetohydrodynamic approximations. Experiments were carried out with high- and low-density bursts in agreement with the approximate calculations used. Special attention was paid to the study of magnetic moments of the bursts, dramatically exemplifying differences in interactions of low- and high-density bursts. All experimental results are in very good agreement with the theoretical predictions. (JPRS)

5267 (N-66-30595) ANALYSIS OF BOUNDARY LAYER STRUCTURE IN A SHOCK-GENERATED PLASMA FLOW. PART I. EQUILIBRIUM IONIZATION. Knoos, Stellan (Stanford Univ., Calif. Dept. of Aeronautics and Astronautics). May 1966. 170p. (NASA-CR-76247; SUDAAR-277). CFSTI $3.00 cy, $0.65 mn.

The structure of some convective, laminar boundary layers in a high density shock-heated 1-eV argon plasma is investigated theoretically. A general three-fluid continuum formulation of the problem is presented, and the equations solved for the case of thermochemical equilibrium with no applied electromagnetic fields. Solutions for boundary layer profiles and other quantities are presented for plasma boundary layers forming over a cold, infinite flat plate with an impulsively started motion in its own plane (Rayleigh's boundary layer) and the boundary layer behind a plane, ionizing shock wave moving over an infinite plane wall (shock tube side-wall boundary layer). Accurate transport data for partially ionized argon are calculated and used in the analysis. The induced electric field is shown to be of fundamental importance to these properties. Associated with the ambipolar diffusion is an electric potential difference of the order 10 V, which is much larger than the potential difference across the sheath. The assumptions of chemical and temperature equilibrium are checked in a rigorous way. It is found that equilibrium ionization will not exist close to the wall below typically 10,000°K, and that the electron temperature, which was calculated in a linearized model, is larger than the ion–atom temperature in the same region. (auth)

5268 (N-66-32129) RELATIVISTIC BREMSSTRAHLUNG IN A PLASMA. Anand, S. P. S. (Yale Univ., New Haven, Conn. Observatory). [1965]. 32p. (NASA-CR-76633). CFSTI $3.00 cy, $0.65 mn.

The problem of a test particle moving through a plasma, causing in the process the emission of radiation by the plasma electrons, is treated for relativistic conditions. Expressions for longitudinal and transverse electric field components as well as for the radiation spectrum are derived. It is found that relativistic effects are only quantitative in nature and do not alter the general behavior of the spectrum. In particular, no new resonances are found. If the plasma ensemble is nonrelativistic and interacts with a single relativistic test particle, the location of the resonance is the same as in the case of a nonrelativistic test particle. (auth)

5269 (N-66-32303) PLASMA RESONANCE RADIATION. Altschuler, Martin D. (Yale Univ., New Haven, Conn. Observatory). [1965]. 32p. (NASA-CR-76663). CFSTI $3.00 cy, $0.65 mn.

The spectral characteristics of electromagnetic radiation in the neighborhood of the plasma frequency are derived. The linearized hydromagnetic equations are used to find the self-consistent electric field of a test particle in the plasma. From this electric field the acceleration of an electron and the radiation emitted in this process are determined for a single encounter of electron and test particle. The spectrum of the radiation emitted by the electrons surrounding the test particle is found by integrating the emission spectrum of a single encounter over a suitable range of impact parameters. When the relative speed of the test particle is less than the thermal speed of the plasma electrons, the spectrum agrees with calculations based on a spherical Debye potential for the test particle. For a test particle speed greater than the thermal electron speed a resonance arises near the electron plasma frequency. The energy emitted at this resonance is calculated and is found to increase with the test particle speed, whereas the energy emitted in the neighboring continuum decreases. (auth)

5270 (N-66-32304) PLASMA RESONANCE RADIATION AND TYPE III BURSTS. Oster, Ludwig (Yale Univ., New Haven, Conn. Observatory). [1966]. 18p. (NASA-CR-76661). CFSTI $3.00 cy, $0.65 mn.

Altschuler's hydrodynamic theory of plasma resonance radiation induced by single test particles is extended to particle ensembles. It is shown that his expressions agree with the known results of kinetic theory in the case of thermal equilibrium. Next, the situation of a high-temperature plasma permeated by fast particle clouds is considered, spectrum and total power emitted are calculated, and the results compared with type-III bursts. It is found that the observed values can be represented by assuming a total of 10^{32} cloud particles in units of 10^7 particles, with each cloud occupying about 10^3 cm^3. The number of fast particles in the source area is thus less than 10^{-4} of the coronal electron density. (auth)

5271 (NP-16397) OSCILLATIONS AT THE ANODE OF ALKALI VAPOR ARC PLASMAS. Semiannual Progress Report No. 4, December 1, 1965–May 31, 1966. Robertson, Harry S. (Miami Univ., Coral Gables, Fla. Dept. of Physics). 31p.
Plasma Phys. Bull., Vol. 6, No. 2, August 1966.

The theory of the anode sheath for quasi-neutral collision dominated arc plasmas is developed, both for the steady state and for behavior following emission of a burst of ions from the anode surface. It is shown that the decay time constant for such a burst is related to the ambipolar diffusion time $\tau = \Lambda^2/D_a$, where Λ is the appropriate diffusion length. A summary is given of experimental work on the anode spot oscillations, some of which supports the predictions of the theory. (auth)

5272 (UCRL-16997) OPERATION OF THE HOMOPOLAR GUN II COIL SYSTEM. Halbach, Klaus; Hopkins, Donald B. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 27, 1966. Contract W-7405-eng-48. 27p. (CONF-661016-26). Dep. mn. CFSTI $3.00 cy, $0.65 mn.
From Symposium on Engineering Problems of Controlled Thermonuclear Research, Gatlinburg, Tenn.

The coil system of the Homopolar Gun II experiment is designed to allow production of grossly different field configurations by properly adjusting the relative position and currents of the coils. The currents in the individual coils are controlled by crowbarring all coils but one with ignitrons at appropriate times. The circumstances of the experiment require that the coils be in series and be energized by a single capacitor bank. The system used to rapidly create a desired field distribution is described. The adjustment of the many interacting parameters of the system can be reduced to the solution of linear algebraic equations. These are solved with the aid of an analog computer. An operational amplifier manifold sums, integrates, and (or) inverts search-coil signals. A storage oscilloscope conveniently displays the deviation of the accomplished field distribution from the desired field distribution. (auth)

5273 (UCRL-50148) ELECTRON INTERACTIONS AND QUANTUM PLASMA PHYSICS. Rauscher, Elizabeth A. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 28, 1966. Contract W-7405-eng-48. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The "quantum electrodynamics" of the scattering of radiation from a fully ionized, interacting plasma is considered. The plasma particle interaction must properly be treated quantum mechanically when the electron plasma wave phonon energies are comparable to or greater than the mean random electron energies and/or when the phonon momenta are of the order of magnitude or greater than the average electron momenta in the plasma. A calculation of the generalized dielectric constant for both a low-density plasma in the classical limit and a high-density plasma in the quantum mechanical limit is performed and compared in a suitable manner. (M.O.W.)

5274 (NP-tr-1432) BEAM NEUTRALIZER FOR INTENSE ION BEAMS. Butusov, V. I.; Mukhin, P. A.; Svishchev, V. S. Translated for Culham Lab., Abingdon, Eng., from report IAE-1098. 13p. (CTO-300). Dep. mn. CFSTI $1.00 cy, $0.50 mn. JCL $1.60 fs, $0.80 mf.

To obtain a flux of fast hydrogen atoms for injection into the magnetic trap in Ogra-II, a target in the form of a supersonic gas jet crossing the ion stream is used. The gas is condensed at the cold surfaces of the neutralization chamber. Two types of target, carbon dioxide and magnesium vapor, are investigated. Disadvantages of the CO_2 target led to the development of a magnesium target which gives a large yield of excited atoms with an energy of 20 keV. The design of the neutralizer and the auxiliary equipment for controlling the magnesium vapor jets are described. (M.O.W.)

5275 CONVERSION OF A TRANSVERSE ELECTROMAGNETIC WAVE TO A LONGITUDINAL WAVE AT THE BOUNDARY BETWEEN A PLASMA AND A DIELECTRIC. Fedorchenko, A. M. (Kiev State Univ.). Zh. Tekh. Fiz., 36: 1327-32(Aug. 1966). (In Russian).

The author earlier discussed in the hydrodynamic approximation the conversion of a transverse electromagnetic wave into a longitudinal plasma wave at a plasma–dielectric boundary. In all those calculations, the condition $v_n = 0$ was imposed at the plasma–dielectric boundary, where v_n is the normal component of the electron velocity. In more recent work a new technique was developed involving Laplace transformations in both the space and time variables for treating analogous boundary value problems. The Laplace transformation technique is employed to calculate the intensities of the reflected wave, the refracted transverse wave, and the transmitted longitudinal wave that arise when an electromagnetic wave is incident at an arbitrary angle on the boundary between a dielectric and a plasma. The incident wave is assumed to be polarized with the electric vector in the plane of incidence. The simplifying assumptions employed in the author's earlier work are used also. The results of the present calculations agree with those of the earlier ones when and only when the dielectric constant D of the dielectric is unity. It is concluded from this that the boundary condition $v_n = 0$ is correct only when $D = 1$. The maximum conversion of the incident transverse waves to longitudinal waves occurs when $\sin^2 i = d/D$, where i is the angle of incidence and d is the dielectric constant of the plasma. (ATD)

5276 NONLINEAR PRODUCTION OF PLASMA WAVES BY A BEAM OF TRANSVERSE WAVES. II. Kovrizhnykh, L. M.; Liperovskii, V. A.; Tsytovich, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1339-50(Aug. 1966). (In Russian).

An earlier paper discussed the passage through an isothermal plasma of a parallel monochromatic beam of transverse waves whose frequency f is much higher than the Langmuir frequency f_0 of the plasma and the accompanying decay of the transverse waves into longitudinal plasma waves. These calculations are extended to the case when the transverse wave beam is not strictly parallel, but has a small angular divergence. The present calculations are based on the results of the earlier ones, and notation employed in the earlier paper is sometimes used in the present discussion without definition. It is found that there is a critical angular spread of the beam given by $\theta_c = (f_0/f)^{1/2}$. When the angular spread of the beam is small compared with θ_c the results previously obtained for a strictly parallel beam are valid. When the angular spread exceeds θ_c the rate of decay to longitudinal waves decreases with increasing beam spread and eventually becomes smaller by a factor of f_0/f than the rate of decay in the case of a strictly parallel beam. Formulas are derived for the rate of decay and for the directions with respect to the beam in which the longitudinal waves propagate, and the passage to the limiting case of zero beam divergence is carried through. The effect of a longitudinal magnetic field is discussed. The magnetic field has little effect on the critical beam divergence, but there appear new decay modes into waves having the Larmor frequency. The decay into longitudinal waves of the Larmor frequency is always slower than the decay into Langmuir waves, however, and does not contribute significantly to the absorption of transverse waves in the plasma. (ATD)

5277 DIFFUSIVE SPREAD OF A PLASMA CONDENSATION AND THE OPTIMUM LENGTH OF A PLASMA ACCELERATOR. Baranov, V. Yu.; Musin, A. K.; Timofeeva, G. G. (Lenin All-Union Electrotechnical Inst., Moscow). Zh. Tekh. Fiz., 36: 1387-93(Aug. 1966). (In Russian).

A theory was given earlier for the acceleration of plasmas in a rail accelerator, in which the effects of electrode erosion and diffusive scattering of the plasma particles were taken into account and from which it was concluded that there are optimal lengths of the plasma gun for maximum energy of the plasma, maximum momentum of the plasma, and maximum efficiency. Experiments were made in order to test this theory and to investigate factors that were not included in the theory. Plasmas were produced and accelerated by the 0.5- to 7-kV discharge of a 110-uF capacitor in a coaxial or rail accelerator from 0.1- to 43.0-cm long. The electrode diameters in the coaxial accelerator were 1.0 and 3.3 cm, and the rail accelerator was so designed as to have the same inductance per unit length. In most of the experiments the pressure was kept below 10^{-3} mm Hg. The velocities of the plasmas were measured with the aid of two double probes, and their momenta were measured with a dynamic pendulum. High-speed cinematograms and streak photographs were obtained of the plasmas in the rail accelerator. The results of the experiments were in qualitative agreement with the theory. It is concluded that there are optimum lengths of the plasma gun for maximum velocity of the plasma, maximum momentum of the plasma, and maximum efficiency of the conversion of electrical energy into kinetic energy of the plasma; that these optimum lengths are determined by the equilibrium between the acceleration process, friction, and diffuse scattering of the plasma; and that thermal expansion of the accelerated plasma in its center of mass system takes place and has a measurable influence on the characteristics of the accelerated plasma bursts. (ATD)

5278 ELECTROSTATIC OSCILLATIONS IN BOUNDED DIELECTRICS, SEMICONDUCTORS, AND PLASMAS. Kheifets, M. I. Zh. Tekh. Fiz., 36: 1516-19(Aug. 1966). (In Russian).

The homogeneous and inhomogeneous proper oscillations of a semiconductor or plasma ellipsoid are discussed with particular attention to the limiting cases of an infinite circular cylinder or an infinite plane slab. The dielectric tensor is written in the form $\epsilon_{ik} = \delta_{ik} + 4\pi\chi_{ik}$ and the proper frequencies are obtained from the equation $|\delta_{ik} + 4\pi n_{ii}\chi_{ik}(\omega)| = 0$ where the n_{ii} are the depolarizing factors. Expressions for the dielectric tensor of a plasma and of a semiconductor, both in an external magnetic field, are substituted into the above equation and the roots are discussed for limiting values of the depolarizing factors. It is shown that homogeneous oscillations can exist even in an isotropic medium. The inhomogeneous oscillations of a slab are discussed, dispersion equations are derived, and the conditions on the dielectric tensor are found under which symmetric and antisymmetric solutions exist. (ATD)

5279 INFLUENCE OF THE FRINGE FIELD OF A PLANE ELECTROSTATIC CAPACITOR ON THE FOCUSING OF CHARGED PARTICLES. Malov, A. F.; Fedoseev, E. P. Zh. Tekh. Fiz., 36: 1351-6(Aug. 1966). (In Russian).

The focusing of charged particles in the x-y plane of a rectangular Cartesian coordinate system x, y, z by the electrostatic field of two charged plates filling the half planes $y = \pm h$, $x = 0$ is discussed. The field obtained by the conjugate function (complex transformation) method is expanded about the x axis in powers of y, terms of higher order than y^2 are neglected, and the differential equation of the trajectory is derived. The trajectory equation was solved by successive approximations for arbitrary initial conditions in the plane $x = -3.6h/\pi$ and the results are presented in the form of equations suitable for application to specific problems. Equations are given for the focal length of the fringe field, the lateral displacement of the focus, and the angular aberration. These quantities are calculated for a specific numerical case to illustrate the use of the equations. The equations can also be employed to calculate the effect of the fringe field of a cylindrical capacitor of the type frequently used in mass spectrometers and the like, provided the radius of the cylindrical capacitor is large compared with the distance between its plates. (ATD)

5280 PERTURBATION OF A BEAM PLASMA BY THE FIELDS OF THE OSCILLATIONS THAT ARISE IN IT. Levitskii, S. M.; Shashurin, I. P. (Kiev State Univ.). Zh. Tekh. Fiz., 36: 1364-71(Aug. 1966). (In Russian).

Earlier investigations were continued on the plasmas produced by ionization of the residual gas in a low-vacuum chamber by an electron beam ("beam plasmas"). The present experiments, using the apparatus described, were undertaken in an effort to elucidate some of the complex phenomena previously noted in connection with the oscillations that arise in beam plasmas. The beam plasmas were produced in a more than 18-cm-long, 1-cm-diameter glass tube containing hydrogen at from 10^{-4} to 10^{-1} mm Hg by an up to 25 mA beam of 0.5 to 1.5-keV electrons in the presence of an up to 500 Oe longitudinal magnetic field. The electron densities in the plasmas were determined from the shift in the resonant frequency of a cavity resonator enclosing part of the discharge tube, and the intensity of the plasma oscillations were observed by recording the strength of the signals in the 350- to 750-MHz range picked up by a loop. In some of the experiments the electron temperature was measured with the aid of three mm diameter plane surface probes. As a function of the electron beam current, the plasma density first increased linearly, then remained approximately constant in a certain beam current range (from about 3 to 12 mA in one case), and finally increased rapidly with further increase of the beam current. The radio noise intensity behaved similarly. The distribution of plasma density and noise intensity along the length of the tube with constant beam current was also complex: under some conditions the plasma density was constant over about one-third the length of the tube (nearest the electron gun), decreased to a minimum, and increased on approaching the anode; under these conditions the noise intensity was very low in the constant plasma density region and was maximum in the region where the plasma density gradient was large. The observed phenomena are accounted for as results of heating the plasma by its own high frequency oscillations. That such heating can occur was established by injecting rf power at the appropriate frequency into a quiet beam plasma and observing a rise in temperature. As the plasma electron temperature rises the ambipolar diffusion constant increases, and the electron density tends to decrease. When the electron temperature is sufficiently high, however, the plasma electrons ionize residual gas atoms, and the electron density tends to increase. The observed behavior of the system is ascribed to competition between these two processes, the consequent effect of the strength of the oscillations on the electron density, and the effect of the electron density gradient on the strength of the oscillations. (ATD)

5281 TRANSVERSE SEPARATION OF THE COMPONENTS OF A MIXTURE IN THE POSITIVE COLUMN OF A GLOW DISCHARGE. Pekar, Yu. A. (Tula Polytechnic Inst., USSR). Zh. Tekh. Fiz., 36: 1372-5(Aug. 1966). (In Russian).

A theoretical discussion is presented of the transverse distribution of the neutral atoms of the low-concentration component (impurity) in a mixture of metal vapor and an inert gas in the positive column of a plane-symmetric discharge. The hydrodynamic equations were employed to describe the electrons of the multicomponent heterothermal plasma, and the heavy particles were described with the aid of nonequilibrium thermodynamics. Diffusion equations for the electron and impurity concentrations were derived, and their solutions are discussed in the two limiting cases in which the contribution of the impurity atoms to the excitation and ionization of the plasma is overwhelming or negligible. The solution for the first case with the boundary condition that the partial pressure of the impurity at the wall of the chamber be equal to the vapor pressure of the condensed material is discussed in some detail, and numerical results are presented for mercury impurity in helium. In this case there is a maximum discharge current above which steady conditions cannot obtain. It is concluded that decrease of the impurity concentration along the column leads to enhancement of the transverse separation and the electron temperature, as a result of which the host gas radiates brightly in the central region of the column and the impurity radiates mainly in a thin shell near the chamber wall. (ATD)

5282 POSSIBLE PRODUCTION OF SURFACE WAVES IN THE INTERACTION OF PLANE WAVES WITH A PLASMA. Alanakyan, Yu. R. Zh. Tekh. Fiz., 36: 1519-21(Aug. 1966). (In Russian).

The interaction is discussed for two plane electromagnetic waves of different frequency incident from a vacuum onto the infinite plane boundary of a plasma. The thermal velocities of the plasma electrons are assumed to be much lower than the phase velocity of the waves. An equation for the field within the plasma of waves with frequency equal to the difference between the frequencies of the two incident waves, said to be derived from Maxwell's equations and the "material equation," is quoted from an earlier paper, and approximate solutions of that equation for E waves and H waves are obtained with the aid of further results from the earlier paper. The amplitude of the E-wave field within the plasma is independent of time, as is also that of the H-wave field unless the difference frequency is equal to the frequency of a proper surface wave. In the latter case the amplitude of the proper surface wave of the difference frequency increases linearly with time. The results are valid in the limit of low incident wave amplitude. (ATD)

5283 INTERACTION OF AN ELECTRON BEAM WITH A BOUNDED PLASMA IN THE PRESENCE OF A MAGNETIC FIELD. Karplyuk, K. S.; Levitskii, S. M. (Kiev State Univ.). Zh. Tekh. Fiz., 36: 1402-8(Aug. 1966). (In Russian).

An investigation was made in the hydrodynamic approximation with neglect of the thermal motions the oscillations of a plasma filament in a longitudinal magnetic field through which there passes an electron beam. The boundary conditions at the plasma-dielectric boundary are derived and the calculations are carried through to the point where the dispersion equation can be written for any particular cylindrical system. The dispersion equation for slow waves is derived for the case of a metallic tube uniformly filled with the plasma and the electron beam, and analytic expressions are obtained for all six of its roots for the limiting case of a low intensity electron beam. Solutions of the dispersion equation for the case of a more intense electron beam were obtained with the aid of a computer, and these, as well as the analytic solutions, are discussed. Regions are found in which wave amplification occurs. These regions are delineated and the dependence of the gain on the type of oscillation is discussed. In the case of certain nonaxisymmetric oscillations the equations indicate that the gain is greater for the higher order oscillations than for the lower order ones; this unusual behavior may actually not occur, however, because of the increase with frequency of the plasma waveguide attenuation, which was not taken into account in the calculations. (ATD)

5284 INTERACTION OF PLASMA BURSTS WITH AN AXIALLY SYMMETRIC MAGNETIC FIELD. IV. Azovskii, Yu. S.;

Guzhovskii, I. T.; Pistryak, V. M. Zh. Tekh. Fiz., 36: 1357-63(Aug. 1966). (In Russian).

Results are presented of a continuation of earlier work on the interaction of the plasmas from a conical-electrode plasma gun with an axially symmetric magnetic field. The plasmas from the conical gun entered the 20 cm diameter plastic tube with a velocity of about 6×10^6 cm/sec and a charged particle density of about 2×10^{13} cm^{-3}. A longitudinal magnetic field of up to 1.2 kOe was maintained in the drift tube by a solenoid. The plasmas were investigated with a double electric probe consisting of two parallel 0.8 mm diameter 5 mm long molybdenum wires mounted 2 mm apart. The probe could be moved both radially and axially and was used to investigate the structure of the plasmas and their radial and longitudinal expansion in different parts of the drift tube. Three regions of extreme values of different plasma parameters were noted; a region of maximum induced current (recorded with a magnetic probe), a region of maximum particle density, and a region of minimum radius and maximum temperature. The maximum induced current and particle density regions occurred in the inhomogeneous portion of the magnetic field; the minimum radius region was farther from the plasma gun in the homogeneous part of the field. In strong magnetic fields a portion of the plasma was reflected by the field and formed a peculiar plasma "cushion" which exerted a definite influence on the interaction between the plasma and the field. The longitudinal expansion of the plasma in the uniform field region was much more rapid than the radial expansion. Plasma temperatures derived from longitudinal expansion velocities were in good agreement with the temperatures given by the probe measurements. (ATD)

5285 PLASMA FREQUENCY BY MULTIPLIER IN A HETEROGENEOUS SUPERHIGH FREQUENCY. Brandt, A. A.; Tyagunov, A. V. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 3, 91-3 (May-June 1965). (In Russian).

Plasma frequency multipliers based on the nonlinear properties of the plasma have a very low conversion efficiency because the plasma is only a slightly nonlinear medium. However, very good efficiency was obtained in the 10-cm band. This was attributed to special design features, including the use of electrodes which created a strongly inhomogeneous high-frequency field. This was assumed to be due to the motion of electrons within the nonharmonic inhomogeneous ac field which leads to the transfer of the energy of the ground frequency field to that of the harmonics field. This is obviated if the charge motion follows the harmonic law. It was shown mathematically from the above that the harmonic motion of the charge in the inhomogeneous field produces high harmonic components of the induced current, depending on the field gradient and its derivatives. This reasoning explains the mechanism involved in the operation of the plasma frequency multiplier on the basis of the specific effect of the induced current due to the motion of charges in a system of electrodes which create an inhomogeneous high-frequency field. The problem was also experimentally examined, using a device built according to the above principle. (TTT)

5286 MEASUREMENT OF THE TEMPERATURE AND CHARGED PARTICLE DENSITY IN ARGON PLASMA JETS. Petrova, G. P. pp 96-100 of Issledovaniia po Fizicheskoi Gazodinamike. Predvoditelev, A. S. (ed.). Moscow, Izdatelstvo Nauka, 1966. (In Russian).

Results are given of temperature measurements and of a spectroscopic study of electron and charged particle density in the arc jet of partially ionized argon, for a pressure of 3.7 atm, arc current of 265 A, and discharge voltage of 37 V. The experimental technique is briefly described. (Int. Aero. Abstr.)

5287 METAL PLASMA JET INJECTION INTO VACUUM. Chekalin, E. K.; Shumanov, V. S. pp 101-8 of Issledovaniia po Fizicheskoi Gazodinamike. Predvoditelev, A. S. (ed.). Moscow, Izdatelstvo Nauka, 1966. (In Russian).

Determination was made of the mean time-dependent parameters of motion of an alkaline metal plasma in vacuum. The plasma is produced by vaporization of an alkali-metal electrode during a discharge in a plasma gun. The experimental setup and technique of plasma production and injection into vacuum are described. Superhigh-speed photographs of the process are given. (Int. Aero. Abstr.)

5288 PHOTON INTERACTION IN PLASMA. Suramlishvili, G. I. (Gorkii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 9: 1038-9(1966). (In Russian).

Photo beam excitation of plasma oscillations was studied previously. The phenomenon is produced by photon decay into a photon and plasmon. Examination of the wave processes inside a photon gas clearly indicated that a photon decay into two photons in the nonlinear section of the spectrum is forbidden by the law of conservation. Thus, analytical studies were made of the processes by perturbation theory considering scattering of one photon by another and two characteristic photon gas magnitudes produced by the above process. Energy densities of four-photon interactions, and the frequencies of photon interactions were found. (R.V.J.)

5289 SELECTED PROBLEMS IN SKIN-EFFECT THEORY FOR AXISYMMETRIC PLASMA CONFIGURATIONS. Brunne, Marek Prace Inst. Maszyn Przeplywowych, No. 28, 37-72(1966). (In Polish).

Analyses are presented of several parameters describing the skin-effect mechanism in cases where the plasma and electromagnetic-field geometries are axially symmetric. The coefficients $f_0(p)$, $f_1(p)$, and $f_2(p)$ characteristic of the mechanism are investigated in relation to the quantities determining field and currents in the plasma. The quasi-surface current, surface impedance, Joule heat, Lorentz force, and skin-layer thickness are also considered. (Int. Aero. Abstr.)

5290 PLASMA VORTEX COMPRESSION BY MAGNETIC FIELD. Ladikov, Yu. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 135-7(May-June 1966). (In Russian).

The appearance and equilibrium of plasma vortex current in an axially symmetric alternating magnetic field were described previously. The observed plasma ring current appeared in an electrodeless discharge in the gas chamber at 0.01 to 0.5 mm Hg. The previous theoretical analysis considered only the electromagnetic effects without taking into account the gasodynamic ones. However, assuming that the plasma current ring is also the vortex ring, the gasodynamic effects become important. Therefore, a further analysis was made. (R.V.J.)

5291 PHASE-VELOCITY TAPERING IN CROSSED-FIELD DEVICES. Volkholz, K. L.; Rowe, J. E. (N. V. Philips, Eindhoven, Netherlands. Univ. of Michigan, Ann Arbor). Contract DA-36-039-AMC-00027(E). Int. J. Electron., 21: 63-87 (July 1966).

The possibility of increasing the power output of injected-beam crossed-field devices by tapering of circuit phase velocity and beam velocity is investigated theoretically and experimentally. The hard-kernel-bunch model of the electron beam is used to derive practical circuit tapers which lead to conversion of beam kinetic energy besides the conversion of electron potential energy normally taking place in crossed-field devices. An experimental S-band crossed-field amplifier was constructed with a uniform and a tapered interdigital line and an improvement in power output between 1 and 2 dB was noted. (auth)

5292 DETERMINATION OF PHOTOIONIZATION CROSS SECTIONS ACCORDING TO OSCILLATOR SPECTRAL LINES. Kobzev, G. A.; Norman, G. E.; Seryakov, K. I. (Moscow Inst. of Power Engineering. Scientific-Research Inst. of High-Temperatures, USSR). Teplofiz. Vysok. Temp., 4: 473-9(July-Aug. 1966). (In Russian).

Photoionization and pre-threshold cross sections were evaluated for Al, Ga, In and Sr by extrapolation of the density of oscillator forces beyond the limits of the spectral series. Coincidence of photoionization cross sections with the corresponding oscillator force density is used as a criterion of measurement. Experiments showed that in the case of plasma (with the threshold shift) the cross section is extended into the longwave side toward the undisturbed oscillator force density of the corresponding spectral series. (tr-auth)

5293 DETERMINATION OF THE ELECTRIC CURRENT IN MOVING PLASMA UNDER CONDITIONS OF THERMIONIC EMISSION. Musin, A. K. (All-Union Electrotechnical Inst., USSR). Teplofiz. Vysok. Temp., 4: 480-90(July-Aug. 1966). (In Russian).

An investigation was made of processes of the formation of space-charge layers during the passage of an electric current in a plasma moving in an electric field in the presence of electron thermal emission from the cathode. Volt-ampere characteristics of semi-self-contained currents were obtained for the cases of weak and strong electron emission. It was established that the shape of the volt-ampere characteristics is markedly influenced by the charge redistribution and the formation of the space-charge layers at the electrodes, which occurs when a plasma flows through the interelectrode space in the presence of an external electric field. If the electron emission is weak, the electrons emitted from the cathode partly compensate the positive space charge rising at the cathode, thus facilitating the passage of the electric current through the plasma. The total current is then proportional to the square root of the emission current. When, with increasing cathode temperature, the equilibrium electron concentration equals the electron concentration in the plasma interval, the near-electrode layer disappears, and the electric current passing through the plasma becomes proportional to the applied voltage. With further increase of the emission, the formation of a negative space-charge layer begins at the cathode, the value of the electric field in the plasma interval increases, and the electric current shows a quadratic dependence on the external voltage. At sufficiently high pressure, the electric current becomes more sensitive to the changes in the external voltage than in the case of low pressures. (ATD)

5294 RADIUS OF SPHERICAL THERMAL PLASMA AS FUNCTION OF ENERGY. Belousova, L. E. Teplofiz. Vysok. Temp., 4: 499-502(July-Aug. 1966). (In Russian).

A cylindrical channel of thermally equilibrate plasma was expanded to the case of spherical geometry. The volume losses due to radiation and convection are not considered, in comparison to the heat transfer by thermal conduction. The radius of the internal zone as a function of the power for the third-type boundary condition was obtained at the given temperature of internal (energy carrying) and peripheral (energy free) zones. (tr-auth)

5295 RADIATION FROM AN ELECTRIC DIPOLE IN A MAGNETOPLASMA. Seshadri, S. R. (Sylvania Electronic Systems, Waltham, Mass.). Can. J. Phys., 44: 3053-67(Dec. 1966).

The fields radiated by an arbitrarily oriented electric dipole in an unbounded, loss-free magnetoplasma are synthesized in terms of cylindrical waves, with the direction of the magnetostatic field as their axis of symmetry. Six independent modes specified by two radial and three azimuthal mode numbers are found to be excited. The total radiation resistance of the electric dipole is shown to be obtainable as the superposition of the contributions arising from the individual modes. Integral expressions for the radiation resistance due to the various modes are obtained and are used in the numerical evaluation of the radiation resistance for some typical values of the parameters of interest. The radiation resistance of an arbitrarily oriented electric dipole is found to become infinite in two frequency ranges on account of the gyro- and plasma resonances, as well as at the upper hybrid resonant frequency, and a discussion of the procedure for eliminating the infinite behavior of the radiation resistance is included. (auth)

5296 PROPAGATION OF ELECTROMAGNETIC WAVES IN A PLASMA WITH NEGATIVE IONS. Teichmann, J. (Univ. of Montreal). Can. J. Phys., 44: 2973-99(Dec. 1966).

Small-amplitude electromagnetic wave propagation was studied in a collisionless plasma containing electrons and positive and negative ions having a different charge-to-mass ratio. The Chew–Goldberger–Low approximation is used for an unbounded, homogeneous plasma in a uniform magnetic field under the assumption of charge neutrality. The analysis of the dispersion relation shows new branches of oscillations, in the zero-temperature limit as well. The classification of waves is presented using the Clemmow–Mullay–Allis diagrams calculated for several plasmas of interest: the laboratory $Cs^+ Cl^-$ and $Cl^+ Cl^-$ plasmas and plasma forming the D layer in the ionosphere. New resonances and stop bands were found for the right-hand polarized wave and the extraordinary wave in the low-frequency region. The isotropic wave propagation at the crossover frequencies and for degenerate plasma is discussed. The dynamics of particles is discussed and the frequency regions in which the positive and negative ions move in opposite phase are given. (auth)

5297 PARAMETRIC EXCITATION OF ALFVEN WAVES. Montgomery, D.; Harding, R. C. (Univ. of Iowa, Iowa City). Phys. Lett., 23: 670-1(Dec. 12, 1966).

It is shown that if a dc magnetic field imposed on a plasma is given a small low-frequency modulation, Alfvén waves may be excited in the plasma through parametric resonance. (auth)

5298 NONLINEAR EVOLUTION OF DISTURBANCES IN PLASMAS AND OTHER DISPERSIVE MEDIA. Berezin, Yu. A.; Karpman, V. I. Zh. Eksp. Teor. Fiz., 51: 1557-68(Nov. 1966). (In Russian).

The nonstationary solutions of the Korteweg–de Vries equation which describes the evolution of nonlinear disturbances in a plasma or other dispersive media are investigated. The conditions for disintegration of disturbances into "solitons" are found. The physical meaning of the self-similar solution of the Korteweg–de Vries equation is elucidated. Some general asymptotic relations for nonstationary solutions are obtained. (auth)

5299 INFLUENCE OF RADIATION REABSORPTION ON THE DEVIATION FROM THERMODYNAMIC EQUILIBRIUM. Vorobev, V. S. (Moscow Power Engineering Inst.). Teplofiz. Vysok. Temp., 4: 494-8(July-Aug. 1966). (In Russian).

Deviations from thermodynamic equilibrium, produced by the emission of radiation from a volume of optically dense gas were determined as a result of the reduction of the number of excited electrons and atoms in the gas. Earlier papers dealing with this subject were restricted to optically thin layers. It is assumed that all the excited states and the continuous spectrum are closely related to impact processes and are in relative equilibrium with one another. Both direct radiative processes (spontaneous emission and radiative recombination) and inverse ones (photoionization and radiative excitation) are considered. Account is taken of the reabsorption of all the components of the discrete and continuous spectrum, by replacing the true lifetime of the excited or ionized state by some equivalent lifetime. The role played in the deviation from equilibrium by various radiative transitions is discussed. By way of an example, the nonequilibrium concentrations are obtained for a plane layer of hydrogen plasma. The degree of validity of the approximations employed is discussed. (ATD)

5300 QUASI-LINEAR RELAXATIONS DYNAMICS OF A COLLISIONLESS PLASMA. Ivanov, A. A.; Rudakov, L. I. Zh. Eksp. Teor. Fiz., 51: 1522-34(Nov. 1966). (In Russian).

The dynamics of the quasi-linear relaxation of unstable states of collisionless plasma were investigated. When at initial time small group of electrons has the high velocity in comparison with the other electrons (the small beam in the plasma), the automodel solution of the quasi-linear equation is found. The distribution function has the shape of the step with an abrupt front moving towards the point $V = 0$. Such a feature of the process is shown to take place for a wide class of the initial distribution function and an equation is derived for the velocity of the abrupt front of the wave to determine. The stationary distribution function and the Langmuir oscillations spectrum are found as functions of coordinate in the case of the stationary injection of the electron beam in plasma. (auth)

Production of Plasma

Refer also to abstract 5079.

5301 DETERMINATION OF THE TOTAL ABSORPTION COEFFICIENTS OF AIR HEATED BY STRONG SHOCK WAVES. Petrukhin, A. I.; Proskuryakov, V. A. Zh. Eksp. Teor. Fiz., 51: 1348-57(Nov. 1966). (In Russian).

The emissivity of air was investigated at temperatures between 65 and 13,000°K. The shock waves were produced in a tube by a powerful spark discharge. The law of motion of the shock wave front for initial air pressures between 0.1 and 500 mm Hg was established. The temperature and charged-particle distributions behind the shock wave front were measured by optical methods at initial pressures of 0.1, 0.2, and 0.5 mm Hg. It was found that behind the fronts of such waves there are small regions (with dimensions of 1.5 to 2 cm) in which the plasma parameters are close to their equilibrium values. Radiative losses of the plasma in the equilibrium region adjacent to the front are calculated on basis of the measured temperature and density distributions. The total absorption coefficients of the plasma are determined. (auth)

5302 PLASMA CLUSTER IN ELECTRIC DISCHARGE SHOCK TUBES. Lebedev, E. F.; Fomichev, V. P. Zh. Prikl. Mekh. Tekh. Fiz., No. 3, 132-4(May-June 1966). (In Russian).

Previous studies revealed that up to a certain distance from the discharge chamber, a discharge plasma may move in a gas-filled channel without accumulating a shock-heated plasma in front of it. Such an effect was usually observed at initial pressures less than 1 mm Hg and discharge current above 10^5 Å with mach number 20 to 30. An attempt was made to study a cluster of plasma in an uninterrupted discharge at 60 to 90 cm from the discharge chamber. The results confirmed the assumption about the absence of a clear boundary between the thermal plasma and the plasma of uninterrupted discharge. (tr-auth)

5303 MEASUREMENT OF THE ELECTRIC FIELD STRENGTH IN THE HOMOPOLAR DEVICE. Donskoi, K. V.; Drobyshevskii, E. M.; Rozov, S. I. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 1501-6(Aug. 1966). (In Russian).

The electric field strength was measured in a homopolar device consisting of two 7.2-cm long, 6.8- and 19.6-cm diameter coaxial cylindrical electrodes mounted in the 7.8-cm gap between 29.5-cm diameter pole pieces with 5.2-cm diameter openings. The axial netic field (up to 2.5 kOe) was uniform within 2% throughout the working volume. The device contained air, hydrogen, or argon at pressures from 0.125 to 1.0 mm Hg. The electric field strengths were measured with a double probe consisting of two 0.2-mm diameter 3 to 4-mm-long platinum wires mounted 4 to 6-mm apart. The electric field strength was not at all inversely proportional to the distance from the axis, as it would be if the resistivity of the medium were constant, but tended to increase toward the anode. As a rough approximation, especially in the case of negative polarity, the electric field could be regarded as constant within the volume of the device, and equal to its value at the mean radius. Except in hydrogen at high magnetic field strengths, the electric field strength was proportional to the magnetic field strength. The electrode potential drops were determined by measuring the potential difference between the electrode concerned and one of the probe wires, positioned 3 mm from it. Both the anode and cathode drops increased with increasing magnetic field strength. Randomly appearing cathode spots were nearly always visible. In hydrogen the cathode drop increased more rapidly with increasing magnetic field strength in magnetic fields stronger than 1 kOe than in weaker fields. This behavior is tentatively ascribed to disruption of the oxide film on the electrode by higher energy hydrogen ions, which facilitates field emission of electrons. (ATD)

5304 DENSITY DISTRIBUTION OF THE PLASMA PRODUCED BY IONIZATION OF THE GAS IN A WAVEGUIDE BY A BEAM OF FAST ELECTRONS. Brodskii, V. B.; Zagik, S. E.; Lyutomskii, V. A. Zh. Tekh. Fiz., 36: 1399-1401(Aug. 1966). (In Russian). .

The maximum electron concentration in a waveguide of circular cross section following passage of a pulse of 1-MeV electrons was investigated as a function because of the significance of the maximum electron concentration for measurements of electron recombination and diffusion by the waveguide and microwave resonator techniques. The electron densities were measured at air pressures of 0.1 and 110 mm Hg by exposing photographic films in different cross sections of the waveguide. For small values of z the electron density was proportional to $1/z^2$, but for larger values of z it was proportional to $1/z$. The initial $1/z^2$ dependence is ascribed to the divergence of the primary beam, and the $1/z$ dependence, to scattering of electrons from the wall of the waveguide. Identical results were obtained at both investigated air pressures. At small values of z the electrons were concentrated toward the axis of the waveguide, but the degree of concentration decreased with increasing z, and at $z = 50$ cm the electrons were practically uniformly distributed over the cross section of the waveguide. The photographic measurements were confirmed by measurements of microwave attenuation in irradiated portions of the waveguide. For these measurements the waveguide was closed at different values of z by a plastic wall that stopped the primary electron beam but did not affect the microwave propagation, thus making it possible to measure the attenuation due to the electrons in only part of the waveguide. It is concluded that a diverging beam of fast electrons can be used to produce a uniform dose field in a metallic tube of high atomic number, and it is suggested that this may be useful in radiochemical, biological, and other investigations. (ATD)

5305 MULTIPHOTON IONIZATION OF KRYPTON AND ARGON BY RUBY LASER RADIATION. Voronov, G. S.; Delone, G. A.; Delone, N. B. (Inst. of Physics, Moscow). JETP Lett. (Engl. Transl.), 3: 313-15(June 15, 1966).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu, 3: 480-3(June 15, 1966).

Observation was made of multiphoton ionization of krypton and argon atoms by ruby-laser radiation at an electric field intensity of $\sim 10^7$ V/cm. The ratios of the ionization potentials to the quantum energy show that the ionization can occur by absorption of eight and nine quanta respectively. For the same photon flux, the ratios of the ion signals of krypton, argon, and xenon were measured. (Int. Aero. Abstr.)

5306 THERMODYNAMIC PARAMETERS OF CESIUM IN THE WAKE OF AN INCIDENT AND A REFLECTED SHOCK WAVE. Saitsev, S. G. pp 30-3 of Issledovaniia po Fizicheskoi Gazodinamike. Predvoditelev, A. S. (ed.). Moscow, Izdatelstvo Nauka, 1966. (In Russian).

A discussion is presented of the thermodynamic behavior of cesium vapor in the wake of an incident and a reflected shock wave at 600°K and 1 torr, and 700°K and 10 torr (near dew-point conditions). The temperature and pressure of a cesium plasma in the wake of an incident ($M_s \leq 12$) and a reflected ($M_s \leq 8$) shock wave are given in diagram form. It is found that ionization reaches 80% and the electrostatic/thermal energy ratio reaches 20%. (Int. Aero. Abstr.)

5307 STUDY OF THE STRUCTURE OF THE LUMINESCENCE FRONT IN AN ELECTROMAGNETIC SHOCK TUBE. Makarov, Yu. V.; Maksimov, A. M. pp 81-7 of Issledovaniia po Fizicheskoi Gazodinamike. Predvoditelev, A. S. (ed.). Moscow, Izdatelstvo Nauka, 1966. (In Russian).

Results are presented of a study by phase-synchronized high-speed photography of the propagation of the luminescence front of an air flow in an electromagnetic shock tube at distances of ~20 and >40 cm from the electrode. It is found that an air flow luminescence front consists of a gas discharge plasma, acts as a "piston" in the formation of the shock wave, and disintegrates at some distance from the electrode. Various phases of the propagation of a luminescence front are shown in photographs. (Int. Aero. Abstr.)

5308 IONIZATION AND HEATING OF SOLID MATERIAL BY MEANS OF A LASER PULSE. Caruso, A.; Bertotti, B.; Giupponi, P. (EURATOM-CNEN, Frascati, Italy). Nuovo Cimento (10), 45B: 176-89(Oct. 11, 1966).

When a very intense light beam interacts with a solid wall, a hot plasma layer is formed on its surface and expands towards the light source with a supersonic velocity. A self-consistent model for this process is proposed in which three different regions exist; outside a jet of very hot, low density, and almost transparent plasma moves in the opposite direction of the light beam; by momentum conservation an ordinary shock moves into the undisturbed material. The shocked region is separated from the plasma by a thin layer, where the light is absorbed. The Hugoniot relationships for the shock and the absorbing layer determine all physical quantities in terms of two free parameters. They, in turn, are obtained on the basis of a self-regulating regime and with the detailed analysis of the absorbing layer. (auth)

Stability of Plasma

Refer also to abstract 5245.

5309 (UCRL-70049) INSTABILITIES OF HIGH-TEMPERATURE PLASMAS. Furth, Harold P. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 8, 1966. Contract W-7405-eng-48. 8p. (CONF-661030-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the German Physical Society, Munich, Germany.

Previously, the only theory capable of dealing with the equilibrium and stability properties of finite-size plasmas was the simple hydromagnetic theory, in which the plasma is described as a perfectly conducting fluid. This theory has the attraction of extending favorable prospects for all sorts of magnetic confinement geometries and heating methods. It also has the merit of substantial correspondence with experimental reality in those cases where it predicts instability. Its main failure is that its predicted situations of stable confinement turn out experimentally to be merely situations of reduced instability. During the past five years, effects arising from the finiteness of the confined plasma have been treated with considerably more theoretical sophistication, and the main classes of residual instability have been analyzed. Experiments conforming with the new and more restrictive stability requirements are under way and appear encouraging. A review of these studies is presented. (auth)

5310 DRIFT WAVES IN A FINITE PRESSURE PLASMA. Mikhailovskii, A. B.; Fridman, A. M. Zh. Eksp. Teor. Fiz., 51: 1430-44(Nov. 1966). (In Russian).

It is shown that the low-frequency oscillations of a collisionless inhomogeneous finite pressure plasma consist of two types of waves which are similar to Alfvén and slow magneto-acoustic waves of an homogeneous plasma. Instabilities of a finite-pressure plasma related to spontaneous excitation of the oscillations are discussed. It is demonstrated that, similar to the situation in homogeneous plasma, there is no interaction between resonance particles and Alfvén-type waves in the zero Larmor ion radius approximation. The waves may involve a hydrodynamic instability if the plasma pressure is comparable with that of the magnetic field and the density and temperature gradients are of opposite signs. A large class of plasma instabilities are connected with waves of the magneto-acoustic type; this is due to the important role of resonance particle effects. Some new instabilities of a plasma of this type are considered. As a rule they occur when the relative temperature gradient is comparable to or exceeds the density gradient and is of opposite sign. The ion temperature instability of a finite-pressure plasma observed previously for a low-pressure plasma with $\partial \ln T/\partial \ln n > 1$ is also discussed. It is shown that this instability is not encountered in plasma in which the pressure exceeds the magnetic pressure. (auth)

5311 NONLINEAR INSTABILITY OF OPTICAL FREQUENCIES IN PARTIALLY IONIZED PLASMA. Tsytovich, V. N. Zh. Eksp. Teor. Fiz., 51: 1385-8(Nov. 1966). (In Russian).

Mechanisms of nonlinear instability which can lead to an increase of optical frequency radiation intensity as well as to radiation of frequencies which differ from the transition frequency by a plasma frequency are considered in plasma containing atoms with inverse population of levels. (auth)

5312 DRIFT INSTABILITY IN MERCURY-VAPOR DISCHARGES. Tanaca, H.; Koganei, M.; Hirose, A. (Yokohama National Univ., Japan). Phys. Lett., 23: 679-80(Dec. 12, 1966).

In the dispersion relation of ion waves, the dependence of the cutoff frequency on the electron drift velocity is examined and is explained by the drift instability in a Maxwellian plasma. (auth)

5313 STABILITY OF A FULLY IONIZED NON-MAXWELLIAN ELECTRON-ION PLASMA. Draganu, Mircea. Mathematica, 7: No. 1, 5-31(1965). (In French).

An extension was made to the three-dimensional case of the method developed by Pfirsch for the study of the electrostatic stability of an electron–ion plasma, neutral and homogeneous, completely ionized, and with a non-Maxwellian distribution function which can be represented by a Hermitian series of polynomials multiplied by a Gaussian function. (Int. Aero. Abstr.)

Shielding

5314 (AE-252) NOMOGRAM FOR DETERMINING SHIELD THICKNESS FOR POINT AND LINE SOURCES OF GAMMA RAYS. Joenemalm, C.; Malen, K. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1966. 32p. Dep. mn.

A set of nomograms is given for the determination of the required shield thickness against gamma radiation. The sources handled are point and infinite line sources with shields of Pb, Fe, magnetite concrete ($\rho = 3.6$), ordinary concrete ($\rho = 2.3$) or water. The gamma energy range covered is 0.5 to 10 MeV. The nomograms are directly applicable for source and dose points on the surfaces of the shield. They can easily be extended to source and dose points in other positions by applying a geometrical correction. Also included are data for calculation of the source strength for the most common materials and for fission-product sources. (auth)

5315 (NAA-SR-Memo-11790) OPTIMUM LITHIUM HYDRIDE SHIELD VESSEL DESIGN FOR PROTECTION AGAINST METEOROID PUNCTURES. Schulz, R. B. (Atomics International, Canoga Park, Calif.). May 10, 1966. Contract AT (11-1)-Gen-8. 25p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A meteoroid puncture of a lithium hydride shield vessel will cause degradation of the neutron attenuation properties of the shield, primarily because of hydrogen loss. An analysis was made relating the increase in fast neutron dose rate due to shield vessel meteoroid puncture as a function of mission duration, exposed area, lithium hydride temperature, vessel thickness, and several other factors. The analysis further determines a minimum weight shield, which would consist of a reduced shield vessel thickness and a compensating increased lithium hydride length so that, at the end of the mission life, the design dose rate would be expected. It may result from this analysis that the minimum shield vessel thickness determined by structural requirements is sufficient for meteoroid protection. For shields with temperature gradients that would result in hydrogen loss in preferential areas, a compartmentalized shield is suggested so that these methods may be applied. A discussion of meteoroid protection for the SNAP-8 instrument rated shield is used for an example, and a comparison with the previous design method is included. The conclusion is that a large reduction in shield vessel thickness can be realized for lithium hydride shields by using this method of analysis. (auth)

5316 (SID-64-2037) STUDY OF SPACE RADIATION SHIELDING. Haffner, J. W. (North American Aviation Inc., Downey, Calif. Space and Information Systems Div.). Dec. 1, 1964. 90p.

Three major sources of high-energy nuclear radiation in space (Van Allen belts, solar flares, and galactic nuclei) are discussed, and their spatial, temporal, mass, and energy distributions are quantitatively given. Techniques for calculating the fluxes, rad doses, and Rem doses each produces under various conditions are presented, and the results of several such calculations are listed in tabular form. In addition, the effects these fluxes and doses have upon men and materials, are quantitatively given so that the shielding required for deep space and orbital missions may be readily ascertained. Finally, an example of a deep space mission is presented and analyzed from the standpoint of space radiation shielding. (auth)

5317 (ORNL-tr-1376) CALCULATION OF REFLECTION AND TRANSMISSION COEFFICIENTS OF A SLAB OF A GIVEN MATERIAL FOR THERMAL NEUTRONS: EVALUATION OF THE RADIATIVE CAPTURE GAMMAS (CENTAURE 3 PROGRAM). Brisbois, Jacques; Duco, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-N-564. 64p. Dep. mn. JCL $6.60 fs, $2.12 mf.

A computer program, CENTAURE 3, for the calculation of neutron albedos on a slab of finite thickness by a successive collision method as well as the angular distribution of capture gamma sources produced in the interior of the slab by the incident thermal neutrons is described. The program is in FORTRAN II for the IBM 7094. (D.C.W.)

5318 RADIATION SHIELD. Kyowa, Kogyo-sho. Japanese Patent 1965-28560. Sept. 30, 1965. Filed Nov. 5, 1958.

A radiation shield is proposed for use in reactors, cyclotrons, highly radioactive facilities, etc. Starting with a material of specific gravity over 3.0, composed of 20 wt % of iron and the remaining zinc, lead, etc., shielding blocks are fabricated having either a protrusion in the shape of a trapezoid in cross section, or the corresponding groove. By means of this protrusion and groove, the blocks are piled up engaging each other to form the desired radiation shield. (NSA of Japan)

Solid-State Physics

Refer also to abstracts 4946, 4947, 4984, 5089, 5091, and 5115.

5319 (ARL-66-0149) THEORETICAL INVESTIGATIONS OF THE PENETRATION OF KILOVOLT IONS AND ATOMS IN SOLIDS. Baroody, E. M. (Battelle Memorial Inst., Columbus, Ohio). July 1966. Contract AF33(657)-8853. 46p.

Two distinct problems arising in the theory of ion penetration are discussed. In the first, the Boltzmann transport equation and the method of Mellin transforms are used to calculate moments of the range distribution of particles stopped by elastic collisions in a medium of randomly located target atoms when cross sections are products of factors depending on energy and angle separately. Results are given for inverse power repulsive potentials and, with additional approximations, for Coulomb potentials with Thomas–Fermi screening. The effect of having several kinds of stopping atoms is considered and comparisons with measurements on amorphous WO_3 are included. The representation of range distributions by using moments in an Edgeworth series is also treated. The second problem, the spreading of weak disturbances in crystals, has a bearing on energy loss from focused collision sequences and similar questions. Detailed results are given for the energy loss from a disturbed atom in a simple cubic lattice with central and noncentral forces between nearest neighbors. These include the calculation of additional terms in the expansion which applies at long times. (auth)

5320 (COO-623-115) SOLID STATE PHYSICS PROGRAM. Annual Progress Report. [Smith, Charles S.] (Case Inst. of Tech., Cleveland, Ohio). Nov. 1, 1966. Contract AT(11-1)-623. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This report, covering the period Nov. 1965, through Oct. 1966, includes abstracts of five technical reports issued, brief descriptions of work still in progress, and an outline of proposals for future research. Reports for which abstracts are given concerned electronic structure of liquid metals, internal stress and annealing of Fe films, pressure derivatives of the elastic constants of CaF_2, and energy gaps in disordered systems. Brief descriptions of work on the following are included: magnetic measurements on thin films, thermal expansion of NaF, elastic constants of RbI at low temperatures, pressure derivatives of the elastic constant of Cu, Bloch electrons in a magnetic field, and valence band structure of diamonds. (A.G.W.)

5321 (LA-3599) AN EQUATION OF STATE FOR IRON ASSUMING AN INSTANTANEOUS PHASE CHANGE. Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Iron undergoes a phase transition at 130 kbar, producing two compressive shocks. This transition can be numerically described in one-dimensional hydrodynamic calculations by using a Grüneisen equation of state to calculate the state points off the Hugoniot. The Hugoniot is described by $U_s = 0.463 + 1.275 U_p$ (where U_s is shock velocity and U_p is particle velocity in cm/μsec) from normal specific volume to 0.1190 cc/gm; the Hugoniot pressure is maintained at 130 kbar between 0.1190 and 0.1148 cc/gm; and between 130 and 440 kbar the Hugoniot is described by $U_s = 0.32 + 2.25 U_p$. This treatment of the Hugoniot of iron assumes that the phase change occurs instantaneously. (auth)

5322 (N-66-29299) RESEARCH ON THE PHYSICS OF SOLID MATERIALS. Semiannual Status Report No. 14, November 1, 1965–April 30, 1966. Brotzen, Franz R. (Rice Univ., Houston, Tex.). 35p. (NASA-CR-75814). CFSTI $3.00 cy, $0.65 mn.

Abstracted data and program objectives are presented for three areas of research in the physics of solid materials: solid-state physics, covering magnetic and electric aspects of materials research; physical metallurgy, concerning metallic materials; and chemistry of solids including chemical reactions and thermodynamics involving solid substances. The solid-state research includes such topics as: spin-lattice interaction in paramagnetic crystals, polarization of stimulated emission of lasers, crystal optics of Mössbauer gamma rays, and radiant energy conversion. Some of the studies in physical metallurgy are: microcreep in b.c.c. metals, electrical resistivity of deformed Mo single crystals, electron microscope facility and thin-film research, and energies and entropies of solute atoms in dilute solid solution. Some of the chemistry of solids topics are: free energy of vacancy formation in solids, modified cell cluster theory, crystal structure of complex molecules, and radiation effects on metallic films and solid surfaces. (TAB)

5323 ELECTRON SPIN RESONANCE IN ELECTRON-IRRADIATED n-TYPE SILICON CARBIDE. Van Ryneveld, W. P.; Loubser, J. H. N. (Univ. of the Witwatersrand, Johannesburg). Brit. J. Appl. Phys., 17: 1277-83(Oct. 1966).

The effects of 0.8-MeV electron irradiation on 6H-type hexagonal silicon carbide doped with nitrogen were studied by electron spin resonance and optical absorption methods. After irradiation the optical absorption peak at 16,400 cm^{-1} disappeared and in the ESR spectrum a strong isotropic line, with g value 2.0036 ± 0.0005 as well as six equidistant lines with separation of about 1.4 G and g value 2.0032 ± 0.0005, were observed at room temperature. These lines are probably due to aluminum impurities. On cooling the specimen down to 77°K it was found that the three-line nitrogen spectrum had disappeared and six pairs of anisotropic lines were observed. These were found to be fine structure lines with spin $S = 1$, $D = 0.052 \pm 0.002\ cm^{-1}$, $g_\perp = 2.010 \pm 0.001$ and $g_{||} = 2.005 \pm 0.001$. After heating the crystal to 200°C, the six pairs of lines disappeared and the three nitrogen lines were partially restored. Furthermore, two lines with separation of about 18 G were observed at room temperature. These lines are probably due to hyperfine interaction with the ^{29}Si nucleus or with an impurity, e.g., ^{31}P, with nuclear spin $I = 1/2$. After repeated heating and annealing of the crystal at higher temperatures, the nitrogen ESR spectrum was restored, but the line intensities were now sensitive to light of wavelength 11,000 Å. A model is put forward to explain these effects. (auth)

5324 METHOD OF CALCULATING THE ENERGY SPECTRUM OF AN ELECTRON IN THE FIELD OF MANY POTENTIALS. Hirota, Toru (Shibaura Inst. of Tech., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 488-503(Sept. 1966).

The Schroedinger equation for an electron moving in the field of many potentials is expressed as a kind of difference equation in the approximation that the distances between the centers of adjacent potentials are much larger than the range of a potential. This procedure is exact when the range of the potential approaches zero. By solving the difference equation, an explicit formula for the energy spectrum is obtained which contains a lattice sum of the kind treated first by Ewald. The merit of the method lies in the fact that the potential part is separated from the lattice-structure part as far as possible, and the treatment of the electronic state in the array of many potentials is correspondingly simplified. (auth)

5325 ABSORPTION OF A NARROW BEAM OF BREMSSTRAHLUNG WITH A MAXIMUM ENERGY OF 200 keV IN ALKALI-HALIDE SINGLE CRYSTALS. Vorob'ev, V. A. (Kirov Polytechnic Inst., Tomsk, USSR). Soviet Phys.-Cryst. (Engl. Transl.), 11: 355-6(Nov.-Dec. 1966).

Translated from Kristallografiya, 11: 398-400(May-June 1966).

The absorption of bremsstrahlung in KCl, KBr, and KI single crystals was studied as a function of the sample thickness taking into account the change in spectral composition of the radiation as the latter passes through the crystals. (auth)

5326 EXPANSION OF QUARTZ CAUSED BY IRRADIATION WITH FAST NEUTRONS. Zubov, V. G.; Ivanov, A. T. (Lomonosov State Univ., Moscow). Soviet Phys.-Cryst. (Engl. Transl.), 11: 372-4(Nov.-Dec. 1966).

Translated from Kristallografiya, 11: 422-4(May-June 1966).

On the assumption that the predominant type of process occurring during the irradiation of quartz is the formation of submicroscopic amorphous regions accompanied by a variation in the surrounding crystal lattice, an analytical expression was derived for the dependence of the relative expansion of quartz on the integrated flux of fast neutrons which is in good agreement with the experimental data. (auth)

5327 INCOHERENT SCATTERING OF NEUTRONS AND THE PROBLEM OF RECONSTRUCTING THE MAGNON SPECTRUM. Izyumov, Yu. A.; Medvedev, M. V. Zh. Eksp. Teor. Fiz., 51: 1423-9(Nov. 1966). (In Russian).

A method is developed for determining the state density in the magnon spectrum of a ferromagnetic crystal on basis of data pertaining to inelastic scattering of neutrons. It is shown that measurement of the scattered neutron energy distribution should not be carried out for a perfect ferromagnetic crystal but for a crystal containing a small concentration of nonmagnetic substitution atoms. It is found that in this case the cross section defined by the incoherent single-magnon scattering impurities can be expressed in terms of the density state in the magnon spectrum of a perfect crystal. (auth)

5328 NEUTRON DIFFRACTION IN A POLARIZED CRYSTAL. Baryshevskii, V. G. Zh. Eksp. Teor. Fiz., 51: 1587-91(Nov. 1966). (In Russian).

Due to difference of energies existing between the states of a neutron with the spin directed along the target polarization and opposite to it, it is possible to obtain a resonance reorientation of the neutron spin while applying an alternating magnetic field. Several resonance frequencies are obtained in contrast to the case when there are no diffracted waves in the crystal. (auth)

5329 X-RAY PRODUCTION OF VACANCIES IN PURE AND DOPED KCl AT 4.2 DEG K. Behr, A.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 23: 620-2(Dec. 12, 1966).

The production of α and F centers by x rays in KCl of different dislocation densities and impurities at 4.2°K is studied. The concentration of the vacancies generated at 4.2°K is constant. (auth)

5330 ATOMIC DISPLACEMENT IN PYROLYTIC GRAPHITE BY ELECTRON BOMBARDMENT. Iwata, T.; Nihira, T. (Japan Atomic Energy Research Inst., Tokyo). Phys. Lett., 23: 631-2 (Dec. 12, 1966).

The uniaxial anisotropy of the threshold energy for atomic displacements, the displacement cascade process and the electrical resistivity of Frenkel pairs in well-annealed pyrolytic graphite were investigated from the electrical resistivity change due to electron bombardment in the energy range 0.13 to 1.0 MeV. (auth)

5331 EFFECT OF INTERACTION OF NUCLEAR SPINS WITH SPIN WAVES ON QUADRUPOLE SPLITTING OF NMR LINES. Kurkin, M. I.; Parfenova, N. G. (Inst. of Metal Physics, Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 1460-4 (Dec. 1966).

Translated from Fiz. Tverd. Tela, 8: 1839-46(June 1966).

A study is made of NMR in antiferromagnets whose antiferromagnetic axis lies in the basal plane, account being taken of quadrupole interaction and of the interaction of nuclear spins with spin waves. (auth)

5332 RESEARCH ON MAGNETISM USING NEUTRON DIFFRACTION. Paoletti, A. (CNEN, Casaccia, Italy). Nuovo Cimento (1), 3: Suppl., 667-75(1965). (In Italian).

The use of neutron diffraction techniques for determining magnetic properties, detailed reproduction of the distribution function of magnetic electrons, and determination of form factors is illustrated. (J.S.R.)

5333 F' AND M' TRAPS IN ALKALI HALIDES STUDIED BY MEANS OF PHOTOSTIMULATED THERMOLUMINESCENCE. Scaramelli, P. (Univ., Milan). Nuovo Cimento (10), 45B: 119-31(Oct. 11, 1966).

The nature of some traps in NaCl, KCl, and KBr is investigated by means of correlated experiments on photostimulated thermoluminescence and optical absorption. The glow peaks centered at 149°K in KBr and at 340°K in NaCl are due to the thermal release of F′ electrons; the activation energy E and the frequency ν_0, characteristic of the F′ glow peaks in NaCl, KCl, KBr are: $E_{F'}$ (NaCl) = (0.91 ± 0.06) eV, $E_{F'}$ (KCl) = (0.537 ± 0.005) eV, $E_{F'}$ (KBr) = (0.35 ± 0.01) eV; log ν_0 (NaCl) = 12.3 ± 0.5, log ν_0 (KCl) = 11.4 ± 0.2, log ν_0 (KBr) = 11.1 ± 0.3. Furthermore, comparison of photostimulated thermoluminescence measurements with optical absorption at the maximum of the M band strongly suggests that the traps which are responsible for the glow bands at 228 and 241°K in NaCl are due to M′ centers. (auth)

Theoretical Physics

Refer also to abstracts 5031 and 5385.

5334 (AD-637151) COVARIANT NOETHER IDENTITIES IN COVARIANT FIELD THEORIES. Ray, John R. (Illinois Univ., Urbana. Coordinated Science Lab.). July 1966. Contract DA-28-043-AMC-00073(E). 15p. (R-305). CFSTI $3.00 cy, $0.65 mn.

In covariant field theories such as general relativity the application of Noether's theorem results in a set of identities which are satisfied regardless of whether the field equations are satisfied or not (so-called strong conservation laws). In the conventional formulation these identities contain nontensorial quantities and non-tensorial operations. Thus, for example, the energy-momentum-pseudo-tensor of general relativity is obtained from such formulations. The identities arising from Noether's theorem are written in an obviously covariant form containing only tensors and covariant derivatives. As an example these identities are given for general relativity. (auth)

5335 (NP-16395) GEODESIC MOTION IN GRAVITATIONAL FIELDS. I. INTERNAL SCHWARZSCHILD FIELD. Kuchowicz, Bronislaw (Warsaw Univ. (Poland). Dept. of Radiochemistry). Apr. 1966. 35p. Dep.

The motion of a test body with given mass, energy, and angular momentum in an incompressible fluid sphere was studied in the framework of general relativity. Conditions for the physical parameters of the test body were derived under which the trajectory is of a closed type. It was found that for some choice of the physical parameters there exist two regions wherein particle motion is possible. These two regions form two completely separated domains. The results may be applied either to motion of elementary particles in superdense stars or to motion of celestial bodies in galaxies. (auth)

5336 SPECIFIC HEAT OF A RELATIVISTIC DEGENERATE ELECTRON GAS. Hamada, Tetsuo; Nakamura, Yosiaki (Ibaraki Univ., Mito, Japan). Progr. Theoret. Phys. (Kyoto), 36: 465-72(Sept. 1966).

The specific heat of a relativistic degenerate electron gas is calculated. The result is $c/c_0 = [1 + Ae^2 + Be^2 \ln e^2 + 0\,(e^4 \ln e^2)]^{-1}$ with

$$A = -\frac{1}{2\pi\sqrt{1+x^2}}\left\{\frac{2}{x} + \frac{1}{x}\ln\left(\frac{\sqrt{1+x^2}}{\pi x} + \frac{2}{\pi}\right) + x\left(1 - \ln\left|\frac{1}{2} - \frac{1}{2x\sqrt{1+x^2}} \times \sinh^{-1} x\right|\right) - \left(\frac{3}{\sqrt{1+x^2}} + \frac{2}{x}\right)\sinh^{-1} x\right\}$$

and $B = -[2\pi x\sqrt{1+x^2}]^{-\frac{1}{2}}$, where $x = k_F/m$ is the relativity parameter and c_0 is the specific heat of a relativistic noninteracting gas. The present work may be regarded as a relativistic generalization of Gell–Mann's nonrelativistic calculation. (auth)

5337 ON THE DISCRETE EIGENVALUES OF THE MANY-PARTICLE SYSTEM. Uchiyama, Jun (Kyoto Univ.). Publ. Res. Inst. Math. Sci., Ser. A, 2: 117-32(Aug. 1966).

A system in a static magnetic field which consists of N electrons and M infinitely heavy nuclei is considered. The Schroedinger operator in nonrelativistic quantum mechanics is described. Discrete eigenvalues were found. (M.O.W.)

5338 STUDIES IN THE THEORY OF THE GENERALIZED DENSITY OPERATORS. I. FOUNDATIONS. Brandstatter, J. J.; Peltzer, C. (Stanford Research Inst., Menlo Park, Calif.). J. Math. Anal. Appl., 16: 123-37(Oct. 1966).

A systematic development is presented of a previous theory which will provide a sound basis for further theoretical studies of many-body problems and for applications of these concepts to solid state-physics and quantum chemistry. Particular emphasis is placed on precise definitions of the spaces and operators introduced and on a rigorous mathematical development. (J.H.M.)

5339 CYLINDRICALLY SYMMETRIC ELECTROMAGNETIC FIELDS OF CLASS ONE. Sharan, R.; Tiwari, R. N. (Banaras Hindu Univ., Varanasi, India). Proc. Nat. Inst. Sci. India, Pt. A, 31: 465-76(Sept. 1965).

A search was made for solutions of the electromagnetic field equations which are of class one. A nonstatic cylindrically symmetric metric of class one obtained by introducing a function ψ of ρ and t in the flat metric in cylindrically polar coordinates is considered. The metric is found to be incompatible with electromagnetic distribution. By assuming two of the eigenvalues equal, two solutions were obtained. A similar procedure is adopted by taking ψ as a function of ρ and z. Two types of electromagnetic fields resulting from the consideration of the Rainich algebraic relations for the most general cylindrically symmetric metric of Marder are subjected to the necessary and sufficient conditions for a Riemannian fourfold to be of class one. The solutions obtained correspond to electromagnetic wrenches, in the terminology of flat space–time, along one of the spatial coordinate lines. The electromagnetic fields are uniform and the corresponding Riemannian fourfolds are the products of two surfaces of constant curvatures. (auth)

5340 QUASI-ENERGY OF A QUANTUM SYSTEM SUBJECTED TO A PERIODIC ACTION. Zeldovich, Ya. B. Zh. Eksp. Teor. Fiz., 51: 1492-5(Nov. 1966). (In Russian).

The structure of the solutions of the Schroedinger equation for a quantum system subjected to a classical force which is a periodic function of time is considered. The concept of quasi energy of quasi-stationary states which vary periodically in time is introduced. The radiation from a system consisting of single quanta with frequencies which are multiples of the external field frequency or of groups of quanta which are related to radiative transitions from one quasi-stationary state to another, and in particular, from the lower to an upper state at the expense of the energy of the external field, is considered. (auth)

5341 PULSATING COLLAPSE FROM THE POINT OF VIEW OF AN EXTERNAL OBSERVER. Gertsenshtein, M. E.; Aivazyan, Yu. M. Zh. Eksp. Teor. Fiz., 51: 1405-12(Nov. 1966). (In Russian).

An oscillating collapse as viewed in the coordinate system of an observer located outside a pulsating sphere of constant density is considered. It is shown that for an external observer the shell of the pulsating sphere is always located within the R region, i.e., outside the Schwarzschild sphere. The oscillation period for an external observer is given by formula. In the Schwarzschild coordinate system time is real in the R region and has a constant imaginary additional term in the T region. The Schwarzschild coordinate system is unique in vacuum outside the pulsating sphere. Ambiguity and the imaginary time contribution arise only within matter for which the Schwarzschild metric is invalid. The picture seen by an external observer is discussed. It is shown that compression–expansion symmetry in such a picture is violated. (auth)

5342 SCREENING CONSTANTS FOR RELATIVISTIC WAVE FUNCTIONS. Garstang, R. H.; Mayers, D. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Proc. Cambridge Phil. Soc., 62: 777-82(Oct. 1966).

Formulas for the mean radius and mean square radius of a relativistic Coulomb wave function are obtained. Screening constants for the energy, mean radius, and mean square radius are defined relative to nonrelativistic wave functions and the results of numerical calculations given. It is shown that if the screening constants so determined are added to the screening constants due to the presence of other electrons as found by the s.c.f. method, good agreement is obtained in a case where both effects have been considered together. The value of solving the relativistic wave equation in a Thomas–Fermi field is also shown. (auth)

5343 HIGH ORDER FREQUENCY SHIFT MEASUREMENT AND GENERAL RELATIVITY. Richard, J.-P. (Univ. of Maryland, College Park). Nature, 212: 601-2(Nov. 5, 1966).

In the theory of general relativity, the path of the photon is described as a null geodesic. If the field is static, this implies that the path of the photon obeys a Fermat principle of least time, the speed of the photon being given by $d\sigma/dt = C\sqrt{g_{44}}$, where $d\sigma$ is the relativistic spatial line element; t the coordinate time; g_{44} the time component of the metric; and C the speed of the photon in the absence of a gravitational field. It is pointed out that the general relativistic effect contained in the equation gives rise to a high-order frequency shift. (W.D.M.)

5344 SCHWINGER FUNCTIONS AND THE CLASSICAL LIMIT OF EQUILIBRIUM QUANTUM STATISTICAL MECHANICS. Symanzik, K. (New York Univ., New York). Nuovo Cimento (10), 45B: 269-72(Oct. 11, 1966).

Since quantum mechanics unifies the particle and wave picture of matter, QSM unifies the statistical mechanics of particles and of wave fields, as is most directly seen in the formalism of second quantization. It is therefore to be expected that there exists a classical limit of QSM in which CSM not of particles but of wave fields emerges. It is shown here that this is the case at least in thermodynamic equilibrium, and the precise conditions for this limiting behavior to result in model cases of reduced number of dimensions are discussed. This limit is not of interest for the physical systems hereby considered, since practically and theoretically unrealizable conditions must be imposed. However, from the reduced density matrices in a suitable limit the Schwinger functions (Euclidean Green's functions, i.e., Feynman amplitudes continued analytically from real to imaginary times) of certain relativistic local quantum field theories are obtained. (M.O.W.)

5345 NOTE ON OPERATOR CALCULUS IN QUANTUM MECHANICS. Arthurs, A. M. (Univ. of Wisconsin, Madison). Nuovo Cimento (10), 45B: 256-8(Oct. 11, 1966).

Fuchs earlier introduced a modification of the standard operator calculus of quantum mechanics to take account of the finite domain (the atomic polyhedron) of the wave functions. The criterion employed was that if A denotes the set of wave functions ψ for which the Hamiltonian operator is self-adjoint, an operator calculus may be obtained by admitting all operators which map the set A into itself. Fuchs found, on using certain periodic boundary conditions, that the momentum operator P represented by $-i\partial/\partial q$ is an admissible operator, but that the position operator Q represented by q is not then admissible. To get around this difficulty Fuchs replaced q by an operator ξ equal to the Fourier development of q, together with certain surface operators. However, an alternative operator calculus can be developed. It is based on the choice of a more general representation of the momentum operator. The operator calculus is described. (M.O.W.)

5346 NONZERO-MASS GRAVITON AND FLAT BACKGROUND IN GENERAL RELATIVITY. Droz-Vincent, Ph. (Institut Henri Poincare, Paris). Nuovo Cimento (10), 45B: 245-8(Oct. 11, 1966).

As Rosen earlier pointed out, the introduction of a flat-space metric along with the ordinary metric tensor $g_{\mu\nu}$ leads to some improvements in the formalism of general relativity. A general relativity is now proposed, with mass term, where no flat metric is necessary to write down the field equations, though a flat metric occurs when one solves these equations. (M.O.W.)

5347 ON THE SELECTION OF NONLINEAR SPINOR EQUATIONS. Chepurnykh, G. K. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 3, 82-4(May-June 1965). (In Russian).

Before examining the nonlinear equations for the quantum case, the classical equation derived from the Lagrangian $L = I_1 - mI_0 + W$ was considered. W, I_1, and I_0 are invariant with respect to time inversion and possess solution only under certain specified conditions with respect to both positive and negative energies. The equation for the quantum case was derived from the above. The invariance of the Lagrangian toward strong reflections requires that the spinor field be quantized only by anticommutators, and the scalar and vector fields by commutators. Thus, all of the known transforms of the linear theory may be applied unchanged to the nonlinear case. (TTT)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

5348 ELECTRON SCATTERING ON NUCLEONS AND NUCLEI. Hofstadter, R. (Stanford Univ., Calif.). Nuovo Cimento (1), 3: Suppl., 568-85(1965).

Recent studies made at Stanford on electron scattering on nucleons and nuclei are briefly described. All studies discussed were made with the Stanford Linear Electron Accelerator, whose operation is briefly considered. Results obtained in the study of the nucleon, the ^{40}Ca nucleus, and the upper limit of the electric dipole moment of the electron. (J.S.R.)

5349 SUMMARY OF THE NATIONAL ACTIVITY IN THE FIELD OF HIGH ENERGY. Moneti, G. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (1), 3: Suppl, 759-810(1965). (In Italian).

Research in the high energy field in Italy is briefly summarized under the classifications of strong interaction studies, electromagnetic interactions and nucleon form factors, and double interactions. Under strong interactions meson and baryon resonances and their characteristics, models of interaction by the exchange of a single particle, elastic interactions at very high energy, and other strong interactions such as nucleon-antinucleon and strange particle reactions. Some general considerations on the future of high energy studies in Italy are given. (J.S.R.)

5350 180 DEG POSITRON–ELECTRON SCATTERING AT 200 AND 500 MeV. Browman, A.; Grossetete, B.; Yount, D. (Ecole Normale Superieure, Orsay, France). Phys. Rev., 151: 1094-1107(Nov. 25, 1966).

To test the predictions of quantum electrodynamics, absolute and relative measurements of the positron–electron scattering cross section were made at 200 and at 500 MeV. Recoil electrons were detected with the spectrometer at 0° with respect to the incident-beam direction, and for the range of recoil momenta studied, the elastic-scattering cone was entirely contained in the angular acceptance of the spectrometer. This method permitted high precision and an experimental test of the radiative corrections. The absolute accuracy of the cross sections was 1%. The complete radiative corrections for this experiment are not yet available. However, for purposes of orientation, existing calculations may be extrapolated to the present situation. Then the shape of the recoil spectrum near the incident positron momentum is consistent with the theory if the radiative corrections of the form $1 + \epsilon$ are used (χ^2 probability of 0.5); the shape is in less good agreement if the correction has the form e^{δ} (χ^2 probability of 0.2). The most precise measurements made, where the corrections were about 15%, were in agreement with the theory. The accuracy has to be increased to decide between e^{δ} and $1 + \delta$. If radiative corrections are assumed to be precisely known, the experiment determines 1/K to about 0.6 F, where a violation of quantum electrodynamics of the form $\sigma \rightarrow \sigma_0(1-q^2/K^2)^2$ is assumed, and where σ is the quantum-electrodynamical cross section and q is the four-momentum transfer. A significant increase in sensitivity could be achieved by extending the experiment to available positron energies well above the relatively modest values used. (auth)

5351 TEST OF C INVARIANCE IN THE 3π DECAY MODE OF THE η MESON. Larribe, A. (CEN, Saclay, France); Leveque, A.; Mueller, A.; (and others). Phys. Lett., 23: 600-4(Dec. 5, 1966).

$\eta \rightarrow 3\pi$ decays were studied in a D_2-filled bubble chamber and their Dalitz plot shows a right-left asymmetry $A = -0.061 \pm 0.040$ consistent with C invariance. (auth)

Weak

5352 $\Sigma^{\pm}$ LIFETIME AND THE BRANCHING RATIO $B_{\Sigma^+} \equiv (\Sigma^+ \rightarrow \pi^+ + n)/(\Sigma^+ \rightarrow \text{ALL})$. Chang, C. Y. (Columbia Univ., New York). Phys. Rev., 151: 1081-9(Nov. 25, 1966).

Using 11,000 charged Σ's produced from $K^- + p \rightarrow \Sigma^{\pm} + \pi^{\mp}$ interactions taking place in the 30-in. Columbia-BNL hydrogen bubble chamber, the $\Sigma^{\pm}$ lifetimes and the branching ratio $B_{\Sigma^+} \equiv (\Sigma^+ \rightarrow \pi^+ + n)/(\Sigma^+ \rightarrow \text{all})$ were determined. By means of a least-squares fit to the differential decay distributions for the in-flight sigma decays, the following values were obtained: $\tau_{\Sigma^+} = (0.830 \pm 0.018) \times 10^{-10}$ sec, $\tau_{\Sigma^-} = (1.666 \pm 0.026) \times 10^{-10}$ sec, and $B_{\Sigma^+} = 0.46 \pm 0.02$. (auth)

5353 MEAN LIFE OF THE π^0 MESON. Stamer, P.; Taylor, S.; Koller, E. L.; Huetter, T.; Grauman, J.; Pandoulas, D. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 151: 1108-16 (Nov. 25, 1966).

An estimate of the π^0 mean lifetime was obtained from a sample of 232 $K^{+}_{\pi 2}$ ($K^+ \rightarrow \pi^+ + \pi^0$) decays at rest. The π^0's were detected by the Dalitz mode ($\pi^0 \rightarrow e^+ + e^- + \gamma$), and the decay distances from the K^+ ending to the π^0 decay points were measured. These events were found in an area scanning of an emulsion stack of 600-μm Ilford G5 emulsion pellicles exposed to a 400 MeV/c separated K^+ beam. The observed mean π^0 lifetime is $(1.0 \pm 0.5) \times 10^{-16}$ sec. (auth)

Strong (Baryon-Induced)

5354 A REMARK ON 30 GeV JET SHOWERS. Hasegawa, S. (Waseda Univ., Tokyo); Kawamura, T. Uchusen-Kenkyu, 10: 655-66(Dec. 1965).

Six Ilford G-5 emulsion sheets of 2 in. × 4 in. × 600 μ, exposed to a Brookhaven 30.5-GeV/c proton beam were studied in detail. The correlation among the secondary mesons, namely, the azimuthal asymmetry in the angular distribution of generated mesons in the jet showers, was first examined statistically under the conditions of N_h 0 or 1 and $N_s > 4$, where N_h is the number of slow evaporation tracks, and N_s the number of secondary relativistic particles. The asymmetry factor $Z_0 = (n_f - n_b)/(n_f + n_b)$ was calculated from 65 jet showers, and it was found that 10 events with $n_s \geq 7$ and 28 events with $n_s \geq 11$ were $|Z_0| \geq 0.5$. The nuclear recoil transverse momentum $P_{TN} \approx (1 - K)M\gamma_L \sin \theta_N$, excluding survived protons, was studied by Yajima-Hasegawa method, where $K = K_L$ and θ_N is the deflection angle in LS for the incident nucleon, and $K = K_M$ and θ_N is the one in MS for the target nucleon. It appeared that a real correlation was existent between P_{TN} and K. It was concluded that the statistics were not sufficient to clarify the above problems from the viewpoint of event number. (NSA of Japan)

5355 REMARKS ON THE INTERACTIONS OF 14-GeV PROTONS WITH NUCLEONS. Csejthey-Barth, M. Bull. Inst. Phys. Univ. Libre Brux., No. 28, 1-12(Oct. 1966). (In French).

The momentum distribution of secondary protons in the center of mass system is studied along with the production of charged π and K mesons. The interpretation of the experimental results that is presented here forms part of a larger attempt to understand proton-nucleon interactions at 14 GeV in nuclear emulsions. (G.O.Y.)

5356 STUDY OF THE POLARIZATION OF ANTIPROTON IN $\bar{p}p$ SCATTERING AT 1.18 GeV/c. Dobrzynski, L. (College de France, Paris); Ghesquiere, C.; Xuong, Ng. H.; Tofte, H. Phys. Lett., 23: 614-16(Dec. 5, 1966).

Analysis of 2764 double scattering events of antiprotons at 1.18 GeV/c in the 81 cm Saclay hydrogen bubble chamber yields an asymmetry of $(-2.3 \pm 3)\%$ for the angular region $15° \leq \theta_{cm} \leq 60°$, with an average angle $\theta_{cm} = 28°$. This would correspond to an upper limit of 20% for the polarization of the antiproton at 95% confidence limit. (auth)

Strong (Meson-Induced)

5357 η PRODUCTION NEAR THRESHOLD. Jones, W. G. (Imperial Coll. of Science and Tech., London); Binnie, D. M.; Duane, A.; Horsey, J. P.; Mason, D. C.; Newth, J. A.; Rahman, I. U.; Walters, J.; Horwitz, N.; Palit, P. Phys. Lett., 23: 597-600(Dec. 5, 1966).

A study of $\pi^- + p \rightarrow \eta + n$ near threshold shows that the cross section rises linearly with η momentum and that $\Gamma_\eta < 0.9$ MeV/c^2 (95% confidence limit). (auth)

5358 THE ANGULAR DISTRIBUTION OF BACKWARD ELASTICALLY SCATTERED PIONS AT 3.55 GeV/c. Baker, W. F. (CERN, Geneva); Carlson, P. J.; Chabaud, V.; (and others). Phys. Lett., 23: 605-9(Dec. 5, 1966).

The elastic scattering of 3.55 GeV/c π^+ and π^- mesons by protons was measured at center-of-mass angles between 165 and 177°. The angular distributions for 864 events show a steeply rising backward peak for π^+p, while the shape is less clear for π^-p. (auth)

5359 POLARIZATION OF THE Σ^0 AND THE Λ PARTICLES PRODUCED IN THE REACTION $\pi^- + p \rightarrow K^0 + \Sigma^0$ (Λ) AT 1.17 AND 1.32 GeV/c. Kim, Young S. (Ohio State Univ., Columbus); Burleson, G. R.; Kalmus, P. I. P.; Roberts, A.; Sandler, C. L.;

Romanowski, T. A. Phys. Rev., 151: 1090-3(Nov. 25, 1966). (COO-1545-9).

The polarization of the Σ^0 and Λ particles in the reaction $\pi^- + p \rightarrow K^0 + \Sigma^0$ (Λ) was measured at 1.17 and 1.32 BeV/c, using a spark-chamber– magnet system. Both polarizations are substantial and their angular distributions are clearly dependent on the beam momentum. (auth)

Particle Interactions and Properties (Theoretical)

General

5360 GENERAL THEORY OF DISPERSION SUM RULES WITH SPECIAL EMPHASIS ON THE HIGH-ENERGY CONTRIBUTION. Muzinich, I. J. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev., 151: 1206-14(Nov. 25, 1966).

A covariant technique to extract the useful sum rules contained in the current commutation relations at equal times has been developed by Fubini. This technique is used to derive the independent sum rules at finite momentum transfer from the SU(3) current algebra. In particular, the sum rules are derived coming from the commutator of a vector current with its time component where the particles on the outside of the commutator have spin ½. The high-energy contribution to the sum rules is discussed in terms of the Regge poles of the crossed channel. The Regge representation relevant to the kinematics of the amplitude is treated in detail. The contributions of terms in the commutator other than the usual canonical result are shown to be related to dispersion sum rules more singular at high energy than the usual sum rules. Such contributions are the so-called Schwinger terms. (auth)

5361 EQUATIONS FOR THE AMPLITUDES OF COMPLEX PARTICLE PROCESSES IN SIMPLE MODELS. PART II. Pazdzerskii, V. A. (Tashkent State Univ., USSR). Izv. Akad. Nauk Uz. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 32-4(1966). (In Russian).

A linear equation for inelastic scattering of identical particles was obtained using a system of equations binding the elastic and exchange amplitudes. (R.V.J.)

5362 STUDY OF A COMPOSITE PARTICLE MODEL. Houard, Jean-Claude (College de France, Paris). Can. Phys., 20: 161-228(May-June 1966). (In French).

Composite particle theories, which are defined by the cancellation of a renormalization constant, are studied on the basis of a soluble example. The consequences of this cancellation are investigated especially insofar as they concern the observable differences that may allow one to distinguish an elementary particle from a composite particle. The two basic models studied are Lee's model, which allows for three elementary particles V, N, θ interacting in a Yukawa coupling that permits both reactions $V \rightleftharpoons N\theta$; and another model where N and θ are elementary while V is a composite particle and the only allowable interaction $N\theta \rightarrow N\theta$ results from a Fermi-type coupling. It is shown that the condition for equivalence between these two models is precisely the cancellation of the renormalization constant. It is further shown that, from a certain point of view, elementary as well as composite particles must be treated in the same fashion insofar as the properties of their propagators are concerned. The investigation is then extended in both models to the case $V\theta \rightleftharpoons N\theta\theta$ and the matrices for this process are diagonalized. The parallel between the elementary and the composite particle is then completed by putting the calculations in the framework of perturbation theory. The scattering amplitudes for $V\theta \rightleftharpoons N\theta\theta$ are calculated using theory and some possible uses for these amplitudes are given. (G.O.Y.)

Electromagnetic

Refer also to abstract 5402.

5363 (AD-637210) NEUTRON FORM FACTOR. Chilton, Frank; Uhrhane, F. J. (Stanford Univ., Calif. High-Energy Physics Lab.). June 1966. Contract AF 49(638)-1389. 15p. (HEPL-454). CFSTI $3.00 cy, $0.65 mn.

A functional form for G_n is found which gives an explanation of why $G_n(t) \approx 0$ but $G_n(0)$ does not = 0. (auth)

5364 FORM FACTORS AND MULTIPOLES IN ELECTROMAGNETIC INTERACTIONS. Dubovik, V. M.; Cheshkov, A. A. Zh. Eksp. Teor. Fiz., 51: 1369-73(Nov. 1966). (In Russian).

The electric and magnetic multipoles of the first and second kind are determined for arbitrary spin particles. The electromagnetic current operator is parametrized in terms of the particle multipoles and their average 2n-power distribution ranges. The properties of the current operators under conditions when P and T invariance is imposed are discussed. (auth)

5365 PRYCE THEOREM AND NEUTRINO THEORY OF PHOTONS. Berezinskii, V. S. Zh. Eksp. Teor. Fiz., 51: 1374-84(Nov. 1966). (In Russian).

Recently some possibilities were found and widely discussed which apparently helped to avoid the difficulty shown by Pryce in the neutrino theory of photons. It is shown in the general form for free fields and any N-particle states that the requirements of invariance with respect to spatial relations and true neutrality are incompatible for a compound photon (Pryce theorem). The evidence given covers all the constructions proposed recently. (auth)

5366 NEW METHOD FOR SOLVING THE CASCADE THEORY EQUATIONS. Vaskin, A. I.; Guzhavin, V. V.; Ivanenko, I. P. Zh. Eksp. Teor. Fiz., 51: 1483-91(Nov. 1966). (In Russian).

A new method for solving the equations of electromagnetic cascade theory is described in detail. The method is based on substitution of a simple approximate differential operator for the integral operator describing the electron bremsstrahlung and pair production processes. Some results obtained by employing the method for solving the unidimensional cascade theory equations, in which ionization losses are or are not taken into account, are presented. (auth)

5367 COMMENTS ON INTENSITY-DEPENDENT FREQUENCY SHIFT IN COMPTON SCATTERING AND ITS POSSIBLE DETECTION. Fried, Z.; Baker, A.; Korff, D. (Lowell Technological Inst., Mass.). Phys. Rev., 151: 1040-8(Nov. 25, 1966).

It is shown that the Hamiltonian of an electron coupled to an external radiation field is not Hermitian within the space of Volkov solutions with scattering boundary conditions. This is demonstrated by explicitly showing that the inner product of two states which are asymptotically orthogonal to each other fails to vanish at a finite time. It is further demonstrated that if the momentum operator is Hermitian within the (asymptotically) free-electron states, it fails to be Hermitian within the fully developed Volkov states. Consequently the parameters p and p′ entering into the Volkov solution with scattering boundary conditions cannot be interpreted as the momenta of the incident and emerging electron, respectively. The only consistent use of the Volkov solutions is for nonscattering situations, viz., the emission or absorption of a photon by an electron which is never decoupled from the external field. In the latter case the parameters p and p′ which enter into the energy-momentum conservation formula refer to average initial and final electron momenta. A consistent interpretation requires us also to compute the dispersion in the electron momenta. On this basis a dispersion is also obtained in the scattered frequency, a physically detectable quantity, which is much larger than the intensity-dependent frequency shift. On the basis of general quantum principles, it is also demonstrated: (a) that the Feynman– Dyson S-matrix technique is the correct procedure to use inasmuch as it gives agreement with energy-momentum conservation and unitarity, (b) that Kibble's explanation of energy-momentum conservation is incompatible with quantized perturbation theory, and (c) that in the case of external transverse fields the perturbation expansion yields a polynomial in the field strength. An experiment involving frequency mixing is suggested as a means of obtaining a maximum effect in the "beat" frequency due to the nonlinearity parameter ν^2. (auth)

5368 DOUBLE-PHOTON CONTRIBUTIONS TO MULTIPLE-PHOTON PROCESSES. Cohan, Norah V.; Hameka, Hendrik F. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 151: 1076-80(Nov. 25, 1966).

It is shown that in evaluating the transition probability of a multiple-photon process involving more than two photons, the contributions of the part of the interaction Hamiltonian that is quadratic in the vector potential of the radiation field may be neglected if the vector potential of the radiation field is assumed to be constant in the region of space considered. (auth)

5369 PHENOMENOLOGICAL ANALYSIS OF $K^+\Lambda$ PHOTOPRODUCTION. Thom, H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 151: 1322-36(Nov. 25, 1966).

Low-energy $K\Lambda$ photoproduction cross-section and polarization data are analyzed using contributions from nonresonant perturbation amplitudes associated with p, K^+, Λ, Σ, and K^{*+} propagators, and from a resonant amplitude in one total and final orbital angular momentum state. The resonance is assumed to have an energy of about 1.7 GeV and a width of about 100 MeV. The data are analyzed by assuming that the resonance can be in any one of the angular momentum states from $S_{1/2}$ to $F_{1/2}$, and a χ^2 minimization is performed for each possibility. It is found that the perturbation amplitudes alone give good fits to the cross-section data, and that only a small amount of resonant amplitude in any one of a number of angular momentum states is sufficient to explain the polarization without strongly modifying the cross-section fits. The assumed resonant state in general contributes about 20% to the total cross section, and $P_{1/2}$ and $D_{1/2}$ states give the lowest values of χ^2. The values of the coupling constants obtained herein are compared with those expected from SU(3); approximate agreement is found though the values obtained in the analysis are generally smaller than the SU(3) predictions. The possible contribution of an $F_{1/2}$ resonant amplitude found in the analysis is consistent with that expected from SU(3) for the third resonance. A compilation of all the presently existing KΛ photoproduction data is given as an appendix. (auth)

5370 MODIFIED ANALYSIS OF NUCLEON ELECTROMAGNETIC FORM-FACTOR DATA. Kane, G. L. (Univ. of Michigan, Ann Arbor); Zdanis, R. A. Phys. Rev., 151: 1239-43(Nov. 25, 1966).

It is suggested that the usual procedure for analyzing nucleon electromagnetic form-factor data be modified by retaining in a suitable manner the dispersion-integral contributions present even after removal of known vector-meson contributions. This allows a more general analysis consistent with all known restrictions on the form factors. The form factors are parametrized and the parameters determined by comparison with experimental data. It is possible to obtain reasonable fits to all of the data with a total of two parameters. The resulting form factors are suitable for the extraction of useful numbers, including the residues at the known vector-meson poles. In addition, analytic continuation to the annihilation region is well-defined and allows meaningful comparison with data there. It is not necessary to make statements about the existence of vector mesons other than ρ, ω, φ. The results are used to discuss the ρ dominance of the isovector form factor and to estimate the vector-meson–nucleon coupling constants. (auth)

Weak

5371 (AD-637252) FADDEEV EQUATIONS FOR THE K TO 3π AMPLITUDE. Barbour, I. M.; Schult, R. L. (Illinois Univ., Urbana. Dept. of Physics). 1966. Contract Nonr-1834(05). 52p. CFSTI $3.00 cy, $0.65 mn.

Integral equations for the three pion decay amplitude of the K-meson are derived in the context of a potential scattering model. Non local S- and P- wave separable potentials are used. Some numerical solutions are presented. The shapes of the decay spectra are found to be independent of the potential. The connection with the integral equations of Khuri and Trieman is discussed. A zero range approximation requires that A exp 2_2 > A exp 2_0 data. Some aspects of three body states in the presence of a resonance are investigated. No observable effects of a triangle singularity are found for the cases considered. (auth)

5372 POSSIBLE SCHEME FOR THE NONLEPTONIC DECAYS OF HYPERONS. II. Kaneko, Takao (Meijo Univ., Nagoya, Japan). Progr. Theoret. Phys. (Kyoto), 36: 598-606 (Sept. 1966).

On the basis of the $[\chi\bar{\theta}]$ model for baryons and the assumption that two-body transitions among the hypothetical triplet χ_α are forbidden, sum rules are derived without using the SU(3) symmetry, for the nonleptonic decays of hyperons which coincide with the Sugawara-Lee relation and the relation derived previously in the unitary symmetry limit. Then an attempt is made to derive the $|\Delta I| = 1/2$ rule in two ways, by applying the Okubo-Marshak-Sudarshan theory and by using the results recently derived by Sugawara and Suzuki. Some relations between the decay amplitudes which are essentially equivalent to the $|\Delta I| = 1/2$ rule can be derived. (auth)

5373 MODEL OF WEAK INTERACTIONS OF BARYONS AND LEPTONS. Arbuzov, B. A.; Filippov, A. T. Zh. Eksp. Teor. Fiz., 51: 1389-1401(Nov. 1966). (In Russian).

A model is considered in which weak interactions of two fundamental fields (lepton and baryon fields) are created as a result of the change of the space-time structure at small distances. Universality of weak interactions in the Cabibbo from, the selection rule $|\Delta S| \leq 1$ for all decays and the rule $\Delta S = \Delta Q$ for lepton decays are obtained as a result of the main assumptions made in the model. (auth)

5374 SUM RULES IN HYPERNUCLEAR BETA DECAY. Kim, C. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 151: 1261-6(Nov. 25, 1966).

Sum rules relating axial-vector coupling constants for hypernuclear beta decay, $G_A({}_\Lambda N_i \rightarrow N_f)$, to integrals over kaon energy of kaon–final-nucleus total cross sections, $\mathscr{I}(K^\pm,N_f)$, are obtained by generalizing the previous work on sum rules in nuclear beta decay to hypernuclear beta decay. It is shown that the ratio $\mathscr{I}(K^\pm,N_f)/[Z\mathscr{I}(K^\pm,p) + (A - Z)\mathscr{I}(K^\pm,n)]$ becomes unity in the approximation of neglect of meson-exchange corrections to $G_A({}_\Lambda N_i \rightarrow N_f)$, as in the case of the analogous expression containing $\mathscr{I}(\pi^\pm,N_f)$, $\mathscr{I}(\pi^\pm,p)$, and $\mathscr{I}(\pi^\pm,n)$ in nuclear beta decay. (auth)

5375 NEUTRINO PAIR PRODUCTION IN BOUND–BOUND TRANSITIONS. Steigman, Gary (New York Univ.). Phys. Rev., 151: 1189-91(Nov. 25, 1966).

The lifetime of an atomic state against decay induced by the lepton part of the weak interaction is computed. Lifetimes against such decay, in which neutrino-antineutrino pairs are emitted, are extremely long ($\sim 10^{35}$ to 10^{40} sec in hydrogen). Despite a very strong dependence on atomic number ($\sim Z^{13}$ for the 2P → 1S transition) the power radiated in neutrinos is very small ($\sim 10^{-6}$ erg/gm^{-1} sec^{-1} for iron). In the temperature and density range relevant for this process other neutrino processes are quite small and optical luminosity serves as the major energy loss mechanism for a star. (auth)

5376 DYNAMICS OF THE WEAK INTERACTION ΛN → NN. Kumar, Rajendra; Dass, Guru Vachan (Univ. of Delhi). Phys. Rev., 151: 1244-50(Nov. 25, 1966).

An attempt was made to understand the spin and isospin dependence of the weak interaction ΛN → NN as determined by Block and Dalitz from a phenomenological analysis of the nonmesonic decays of the light hypernuclei ${}_\Lambda He^4$ and ${}_\Lambda H^4$. The calculation is an extension of the pole model used by Lee and Swift for nonleptonic hyperon decays. The CP-invariant weak Hamiltonian was taken to transform like λ_6, a member of the octet representation of SU(3). One-boson-exchange forces were considered for the strong-interaction part; SU(3)-symmetric meson-baryon couplings were used. The weak scalar-pseudoscalar-meson pole was introduced in addition to the vector–pseudoscalar-meson pole for the parity-violating channel. For the parity-conserving channel, scalar-meson exchanges were also introduced in addition to (a) the pseudoscalar and the vector-meson exchanges for the weak-baryon pole diagram, and (b) the weak pseudoscalar-pseudoscalar-meson pole diagram. The results are in fair agreement with the deductions of Block and Dalitz. (auth)

5377 LOW-ENERGY THEOREM FOR THE WEAK AXIAL-VECTOR VERTEX. Adler, S. L.; Dothan, Y. (California Inst. of Tech., Pasadena). Phys. Rev., 151: 1267-77(Nov. 25, 1966). (CALT-68-73).

A low-energy theorem is derived for the weak axial-vector vertex. The theorem enables one to calculate from strong or electromagnetic processes the two leading terms in the expansion of the axial-vector vertex in powers of the leptonic four-momentum transfer. Applications to weak pion production, K_{e4} decay, and radiative μ capture are discussed. In particular, the radiative μ-capture matrix element, up to and including contributions linear in the leptonic four-momentum transfer and the photon four-momentum, are expressed in terms of the elastic weak form factors and pion photoproduction amplitudes. (auth)

5378 APPLICATION OF CURRENT COMMUTATION RULES TO $\Delta Q = 0$, $\Delta S = 1$ DECAY MODES OF HADRONS. Tanaka, K. (Ohio State Univ., Columbus). Contract AT(11-1)-1547. Phys. Rev., 151: 1203-6(Nov. 25, 1966). (COO-1545-7).

The reduction in strength of the order of $f^2 \approx 10^{-4}$ due to the strong interactions that characterize the $\Delta Q = 0$, $|\Delta S| = 1$ decay modes such as $\Sigma^+ \rightarrow p + \gamma$ is obtained from the S-wave nonleptonic decay amplitudes. A weak-interaction Hamiltonian for nonleptonic S-wave decay that transforms like the 7th component of the space integral of the pseudoscalar quark density is assumed. Then, the algebra of current commutation relations of scalar, pseudoscalar, and axial-vector currents, and the partially conserved axial-vector current relation are used to relate the S-wave amplitude of $\Sigma^+ \rightarrow p + \pi^0$ to the weak vertex $\Sigma^+ \rightarrow p$. Extension of the present technique to the decay mode $K^+ \rightarrow \pi^+ + e^+ + e^-$ is also discussed. (auth)

5379 THEORY OF NEUTRAL LEPTONIC CURRENTS. Good, M. L.; Michel, L.; de Rafael, E. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Phys. Rev., 151: 1194-1202(Nov. 25, 1966).

d'Espagnat's theory of weak interactions is extended to include neutral leptonic currents. It is found possible to obtain agreement with the experimental absence of neutral lepton currents in all processes involving hadrons in a natural way, but only by introducing $i \equiv \sqrt{(-1)}$ multiplying the entire leptonic Lagrangian. It is also found natural to couple the μ leptons and the e leptons in symmetrical, but different, ways. The consequences of the coupling scheme, in addition to the sought-for absence of most neutral currents, are: (1) separate conservation of μ and e leptons, (2) a mechanism for the $\mu-e$ mass difference, and (3) production of μ pairs in e-type neutrino scattering and in μ scattering. If, in addition, the decoupling of hadronic and leptonic neutral currents which were set up is broken by any small perturbation, CP violation results. The experimental consequences of two such possible symmetry-breaking mechanisms are discussed. (auth)

5380 AXIAL-VECTOR CURRENT CONSISTING OF PSEUDOSCALAR OCTET. Kuo, T. K.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 151: 1181-6(Nov. 25, 1966).

The boson part of the axial-vector current which satisfies the SU(3) × SU(3) commutator algebra is constructed in terms of the pseudoscalar fields alone. This axial-vector current consists of linear and triple terms in the pseudoscalar fields, all of which are linear in their space-time derivatives. It is shown that there is no octet of such a current which can be constructed in terms of the pseudoscalar octet alone. In fact, no such octet satisfies even the SU(2) × SU(2) portion of the algebra. However, an octet of the axial-vector current can be constructed in terms of the pseudoscalar octet and a pseudoscalar singlet. This axial-vector current satisfies the U(3) × U(3) commutator algebra and is the only current of this kind. Even when the pseudoscalar-singlet part of the current is dropped, this axial-vector current can maintain the SU(3) × SU(3) algebra or the SU(2) × SU(2) algebra in two limits of possible interest. The most general axial-vector current of this type which satisfies the SU(2) × SU(2) algebra is also constructed in terms of the members of the pseudoscalar octet. (auth)

5381 STATUS OF WEAK INTERACTION PHYSICS. Zichichi, A. (CERN, Geneva). Nuovo Cimento (1), 3: Suppl., 894-933(1965). (In Italian).

The present status of weak interaction physics is characterized by the progress made in the comprehension of the following problems: lepton numbers and the corresponding selection rules, new principle of universality and the introduction of SU_3 in weak interactions, the $\Delta I = 1/2$ selection rule and the neutral current, form of weak interactions, the induced pseudoscalar term g_p, the pion structure, neutrino physics, and the decay of K_2^0 into two pions. The most significant developments made in each of these fields are discussed. (J.S.R.)

5382 SYMMETRY PROPERTIES OF THE STATE VECTORS OF TWO UNSTABLE PARTICLES. Jaus, W. (Univ., Zurich). Helv. Phys. Acta, 39: 617-40(1966). (In German).

The statistical behavior of unstable particles is examined. For this purpose the state vector of the unstable V-particle in the Lee model is constructed and its dependence on the excitation condition shown. The state vector of two unstable V's no longer obeys the symmetrization postulate (SP) and the violation of SP is a consequence of the fact, that the V's can decay. As an example of the technique a caculation is made, again in a simple model of the probability, that the long-lived component of K^0 decays into a 2π-state via a CP-invariant decay interaction. This probability measures the deviation from SP of the state vector of two unstable π's, but because it is very small it is concluded that in present experiments the π behaves like an exact boson. (auth)

Strong (General)

5383 (AD-637560) CALCULUS FOR A BOOTSTRAP DYNAMICS. Bastin, Edward W. (Cambridge Language Research Unit (England)). Jan. 1965. Contract AF-EOAR-78-65 32p. (AFOSR-66-0415). CFSTI $3.00 cy, $0.65 mn.

An outline and conceptual basis are presented for a calculus in which the elements are a finite set of similar entities capable of undergoing interactions, and the process of bringing two elements into consideration together constitutes a new element that is of the same kind as the original ones and is capable itself of being brought into consideration with the members of the first set. The elements form a hierarchy and under certain conditions can be simply ordered so that the sets are finite and their order calculable. The simple ordering is used to describe a bootstrap system for interactions between particles and to define the physical quantity of time. A relationship between levels in the hierarchy expresses the recursive nature of each decision by using the total possible number of decisions at each level as the algebraic basis for the set at the next more complex level. The system accounts for dynamic processes in terms of discrete interactions. Its nonformal expression is related to concepts of information transfer. (auth)

5384 (INR-732/VII/PH) SYMMETRIC THREE-QUARK INTERACTIONS. Werle, J. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 12p. Dep.

A simplified treatment of three-quark interactions is proposed. It is based on the nonrelativistic three-particle Hamiltonian which is invariant under the group O_8. Such a symmetry implies that the strongest interactions between quarks are essential three-body interactions. Two-body interactions break O_8 and are responsible for the mass splitting which is two orders of magnitude smaller. The proposed O_8 symmetry simplifies considerably the discussion of energy levels. (auth)

5385 SOME ASPECTS OF RECENT RESEARCH DONE IN ITALY IN THEORETICAL PHYSICS. Verde, M. (Univ., Turin). Nuovo Cimento (1), 3: Suppl., 1071-80(1965). (In Italian).

The nature of theoretical research is divided into two parts. In one group methods dominate the study of classical and quantum kinematics. In the other part the problems of quantum dynamics of collisions in the presence of strong interactions are considered. The most recent research done in Italy in each of these areas is discussed. (J.S.R.)

5386 SOME CONSEQUENCES OF AN INTEGRAL REPRESENTATION FOR THE RENORMALIZATION FUNCTION $Z_3(s)$. Rockmore, Ronald (Rutgers–The State Univ. of New Jersey, New Brunswick). Phys. Rev., 151: 1228-34(Nov. 25, 1966).

An integral representation for the renormalization function, $Z_3(s) = \Delta_F(s)/\Delta_{F'}(s)$, and hence for the composite eigenvalue conditions $Z_3(\infty) = 0$, $\lim_{s\to\infty} sZ_3(s) = 0$ as well, is derived. The representation allows for the possible emergence onto the physical sheet of Castillejo–Dalitz–Dyson (CDD) poles, as the coupling strength increases, by satisfying the requirements of analytic continuation in that parameter. The composite conditions are obtained in a relativistic scalar model (in the elastic approximation) and in a one-pole nonrelativistic model; in confirmation of a surmise due to Ida, these conditions are found manifestly independent of the position of the CDD poles. Applications of the representation to some limit problems in the theory of noncomposite particles, to the Zachariasen model, and to a multichannel generalization of that model are made. The extension of the representation to the nucleon is the basis for a brief numerical analysis of $Z_N(w)$ and related quantities in the one-branch approximation. (auth)

Strong (Baryon No. = 0)

5387 CURRENT ALGEBRA AND ω-ϕ MIXING PARAMETER. Gupta, K. C. (Center for Advanced Study in Theoretical Physics and Astrophysics, Delhi). Phys. Rev., 151: 1250-2(Nov. 25, 1966).

Assuming the current-generated algebra and the partially conserved axial-vector current condition for the strangeness-changing axial-vector current, an attempt is made to relate the F/D ratio parameter f with the ω-ϕ mixing angle. It is concluded that the Adler–Weisberger type of sum rule obtained gives results consistent with previous work. (auth)

5388 TWO-CHANNEL CALCULATION FOR THE ρ MESON BY THE EFFECTIVE-POTENTIAL METHOD. Vaidya, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 151: 1192-3(Nov. 25, 1966).

The width and the mass of the ρ meson are calculated in the coupled $\pi\pi$-$K\bar{K}$ problem, using an effective potential in a Schroedinger equation to unitarize the input. It is found that the coupling to the closed $K\bar{K}$ channel has a considerable narrowing effect on the ρ resonance. The calculation is free of any arbitrary parameter such as cutoffs or the subtraction points. With about 10% self-consistency $m_\rho \approx 5.5$ pion masses and the reduced width ≈ 0.36 are obtained. The effect of f^0 was also included to obtain the reduced width ≈ 0.215 and mass ≈ 4.6. The width of the ρ comes out considerably smaller than in the usual calculations. (auth)

Strong (Baryon No. = 1)

5389 (NYO-2262-103) π-N PHASE SHIFTS FROM PARTICLE EXCHANGES AND ELASTIC UNITARITY. Islam, M. M.; Pinon, R. (Brown Univ., Providence, R. I. Dept. of Physics). Aug. 16, 1965. Contract AT(30-1)-2262. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Within the framework of analyticity, elastic unitarity, and single particle exchange forces, low energy p, d, f, and g wave π-N phase shifts are calculated using a recently suggested approximation technique. N, N*, ρ, and $\sigma(I = 0, J = 0, \pi$-π resonance) exchange forces only are considered. The masses and coupling constants of these particles are taken as known quantities. Results are compared with some of the current πN phase shift analyses. (auth)

5390 NUCLEON EXCHANGE AND THE FREQUENCY DISTRIBUTION OF THE TREIMAN–YANG ANGLE. Bussian, A. E. (High Altitude Observatory, Boulder, Colo.). Phys. Lett., 23: 591-2(Dec. 5, 1966).

A point regarding the frequency distribution of the Treiman–Yang angle associated with the nucleon exchange graph is clarified. The reactions $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ and $\pi^- + p \rightarrow p + \pi^0 + \pi^-$ are considered in the π^- n rest frame. It is shown that one of the conditions for a restriction on the Treiman–Yang frequency distribution does not necessarily follow from the nucleon exchange graph. (J.F.P.)

5391 AN ATTEMPT AT SYSTEMATIZING MESON-BARYON RESONANCES. Otsuki, Shoichiro; Sawada, Shoji (Kyushu Univ., Fukuoka. Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 666-8(Sept. 1966).

A model is proposed which may systematize the level scheme of baryon or meson-baryon resonances. It is based on the assumptions that most of the baryon resonances are well described as composite systems of a low-lying baryon and meson and that the Kycia–Wiley rule can be extended in the manner given. It is examined to what extent the given molecular structure holds in the series of Y = 1 baryon resonances. (J.F.P.)

5392 PION–NUCLEON BACKWARD SCATTERING AT HIGH ENERGIES AND PION STRUCTURE. Namiki, Mikio; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 568-97(Sept. 1966).

By using the impulse approximation under the assumption that the pion can be regarded as a composite system of a nucleon and an antinucleon, the pion-nucleon scattering amplitudes at high energies are written down in terms of the nucleon-nucleon scattering amplitude, the nucleon-antinucleon scattering amplitude and the nucleon-antinucleon bound state wave function. Some backward peaks in pion-nucleon scattering are naturally expected to come from the forward peaks in nucleon-nucleon and nucleon-antinucleon elastic scattering through the exchange or rearrangement effect. This type of backward peak is called the "exchange backward peak." There the probability of finding a nucleon-antinucleon pair in the pion state becomes the only free parameter to be adjusted so as to fit the theoretical curves to the experimental plots. With appropriate values of the probability it is shown that the experimental angular distribution of the $\pi^{\pm}p$ elastic backward cross sections at about 4 GeV/c (of the incident pion momentum in the laboratory system) are well reproduced by the theoretical "exchange backward peak" with the right order of magnitude and the correct forms — including the difference between the backward behavior of π^+p and π^-p scattering. The angular distribution in pion-nucleon scattering at about 8 GeV/c is also obtained with the right order of magnitude, although the statistics of the experiments is too unsatisfactory to compare with the theoretical one in the backward region. Finally it is pointed out that the sharp backward peaks of the $\pi^{\pm}p$ elastic scattering should not originate in the simple "exchange backward peak" but in the backward behavior of the nucleon-antinucleon amplitude coming from the no-pair intermediate states and of the proton-neutron scattering coming from the charge-exchange effect. The sharp forward peak π^-p charge exchange scattering may also be due to the same source. It is shown that the sharp backward peaks cannot be understood by the correction terms from the u-channel resonances unless special form factors are used with a broad range and a small magnitude. (auth)

5393 INTERFERENCE OF REGGE ρ EXCHANGE WITH DIRECT CHANNEL FERMION RESONANCES. Barger, V.; Olsson, M. (Univ. of Wisconsin, Madison). Phys. Rev., 151: 1123-6 (Nov. 25, 1966). (COO–881-71).

Using a Reggeized ρ-meson-exchange background amplitude, information on Y = +1 fermion resonances is obtained from a calculation of the energy dependence of (i) the difference of the π^-p and π^+p total cross sections and (ii) the $\pi^-p \rightarrow \pi^0n$ differential cross section at zero degrees. Some evidence is found for a new I = ½ resonance at 3350 MeV that might be a further Regge recurrence of the N_γ trajectory. Study of the charge-exchange data confirms the validity of the Regge prediction for the phase of the background amplitude. (auth)

5394 BOOTSTRAP MODEL OF BARYONS WITH NONDEGENERATE MESONS. Lin, K. Y. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 151: 1319-22(Nov. 25, 1966). (CAR–882-19).

A static bootstrap model of baryons including N, N*, Σ, Λ, Y_1^*, π, and K is considered. The mass difference between the mesons is treated as a parameter. One solution is found which produces strong attractions in several channels expected to be free from bound states, and which therefore seems not self-consistent. Besides, the mass spectrum of this solution differs from the experimental results. It is concluded that the heavier baryons (Ξ, Ξ*, and Ω), and perhaps also the η, are necessary for self-consistency. (auth)

5395 SPIN-DENSITY-MATRIX ANALYSIS. POSITIVITY CONDITIONS AND EBERHARD–GOOD THEOREM. Minnaert, Pierre (Centre de Physique Theorique, Paris). Phys. Rev., 151: 1306-18(Nov. 25, 1966).

The conditions that the positive-definiteness of the spin density matrix implies on its multipole parameters are derived. The general conditions imposed by the Eberhard–Good theorem are also derived. General formulas are given for arbitrary spin j, and detailed results are worked out for j = 1 and j = 3/2. Some applications of these results to spin determination are considered. (auth)

5396 SPIN EFFECTS ON TRIANGLE GRAPHS. Month, Melvin (Univ. of Illinois, Urbana). Phys. Rev., 151: 1302-5(Nov. 25, 1966).

It is shown that the triangle amplitude can be written as the scalar graph multiplied by a factor which contains only the characteristics of the external particles. In the case where the spins of the external particles are summed, their angles averaged, and only one partial-wave set (that is, a set of relative orbital angular momenta among the final-state particles) retained, this multiplicative factor is just a product of appropriate 3-momenta. The case $K^+p \rightarrow K\pi\pi\pi p$ at 3 BeV/c is considered; and it is demonstrated that the correct inclusion of threshold factors does not diminish the effect calculated in our earlier work, where the shape of the "κ enhancement" was successfully described by a triangle graph. (auth)

5397 SELF-CONSISTENT THREE-BODY CALCULATION OF PION–NUCLEON SCATTERING. Aaron, Ronald (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 151: 1293-1302(Nov. 25, 1966).

Using an off-energy-shell static theory which treats three-particle unitarity exactly, but neglects left-hand cuts, the low-energy P-wave Nπ system is described. A well-satisfied "bootstrap" requirement in the (3,3) channel and a possible explanation for the Roper resonance in the (1,1) channel are obtained. (auth)

5398 DYNAMICAL MODEL FOR BARYON RESONANCES. Mitra, A. N. (Univ. of Delhi). Phys. Rev., 151: 1168-71 (Nov. 25, 1966).

A nonrelativistic three-quark (Q) model of baryons and their resonances is proposed with the assumptions of (i) parastatistics, which, in contrast to Fermi statistics, allows totally symmetric wave functions, and (ii) operation of Q-Q forces of the factorable type in s and p waves, which facilitate an exact solution of the three-body problem. It is found that the s-wave force gives rise to a strong attraction in a spatially symmetric (S) state of L = 0, but repulsion in a mixed-symmetric (M) state. This provides a natural dynamical realization of the 56 representation of SU(6) for the familiar octet and decuplet of baryons. The same s-wave force also predicts a set of negative-parity resonances but these are of much too high energy to be of any physical consequence. The p-wave force leads to a set of negative-parity L = 1 resonances via strong attraction in M-type spatial states of L = 1, thus making up the representation (70,3) of SU(6) × O(3). A p-wave spin-orbit Q-Q force splits these states in a manner which fits in rather well with Dalitz's recent analysis of experimental data for the negative-parity baryonic resonances. Finally, the p-wave force generates a strong attraction in a spatially antisymmetric state (A) of even parity and L = 1, giving rise to the representation (20,3) of SU(6) × O(3), of which the lowest states are an octet and a singlet of $J^P = \frac{1}{2}^+$, the central mass of each lying lower than the corresponding lowest mass multiplet of negative parity. This provides a natural explanation of the so-called "Roper" resonance (at 1450 MeV), and in addition, strongly predicts an even-parity singlet of a mass lower than the $Y_0^*(1405)$. The distinction between Fermi statistics and parastatistics is discussed in the context of the above results, and it is argued that while Fermi statistics could in principle generate negative-parity L = 1 resonances (via M functions), it could not possibly account for the 56 of baryons, since with Q-Q forces alone, the A function of L = 0 that should go with it has a strongly repulsive kernel. (auth)

5399 REMARKS ON THE BARYON MASS SPECTRUM. Gyuk, Imre P. (Syracuse Univ., N. Y.); Tuan, S. F. Phys. Rev., 151: 1253-8(Nov. 25, 1966).

Earlier attempts to classify negative-parity baryon states in the intermediate energy range 1 to 2.2 BeV are reviewed, modified slightly, and generalized. The mass spectrum is analyzed in terms of (i) the basic 70^- and 20^- multiplets of SU(6) and (ii) the 70 (L = 1) of SU(6) × O(3). Connection between these possibilities and a fundamental structure composed of quarks and pseudoquarks for case (i) and quarks with "orbital" excitation L = 1 for case (ii), underlying these mass regularities, are briefly discussed. (auth)

5400 πN PHASE SHIFTS AND EIGENSCATTERING. Goldberg, Hyman (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 151: 1186-9(Nov. 25, 1966).

Small variations in eigenphase and mixing-angle behavior are correlated with distinct types of large variations in the elastic phase shift. Applications to recent results for the P_{11} and D_{13} πN phase-shift analyses are discussed. (auth)

5401 COMMUTATION RELATIONS OF BARYON CURRENTS. Hwa, Rudolph C.; Nuyts, Jean (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 151: 1215-25(Nov. 25, 1966).

The notion of baryon "currents" is introduced. The hypothesis [partially conserved baryon currents (PCBC)] is made that the divergences of these baryon currents are related to baryon fields in much the same way that the hypothesis of partially conserved axial-vector current (PCAC) relates the divergences of axial-vector meson currents to pseudoscalar meson fields. On the basis of the quark model, the baryon currents are constructed as linear combinations of the products of three quarks. Using the canonical anticommutation relations for the quarks, the equal-time commutation relations of the baryon currents with vector and axial-vector meson currents are derived. The right-hand sides of these commutation relations turn out to be linear combinations of the baryon currents themselves. As applications the matrix elements of the commutation relations between vacuum and baryon states and between meson and baryon states are considered. The results consist of algebraic relations between various form factors, which can be checked, in principle, by accurate experimental data when available. (auth)

5402 SELECTED TOPICS IN PION-NUCLEON SCATTERING AND PHOTOPRODUCTION. Hoehler, G. (Technische Hochschule, Karlsruhe, Ger.). Nuovo Cimento (1), 3: Suppl., 651-66(1965).

Recent theoretical and experimental results in charge-exchange forward scattering, other πN forward amplitudes, pion photoproduction below 500 MeV, and pion photoproduction above 500 MeV are critically analyzed. (J.S.R.)

Strong (Baryon No. ≥ 2)

5403 Σ HYPERNUCLEI AND Σ^+-PROTON SCATTERING. Tang, Y. C. (Univ. of Minnesota, Minneapolis); Herndon, R. C. Phys. Rev., 151: 1116-22(Nov. 25, 1966).

By analyzing the Σ^+-proton scattering data at low energies, it is found that the triplet Σ-nucleon interaction in the $I = 3/2$ state is certainly not strong enough to support the formation of a particle-stable Σ^-n or Σ^+p system. The singlet Σ-nucleon interaction, on the other hand, could be quite strong, but it is probably still not sufficient to create a bound two-body Σ hypernucleus. Also, because of the relative weakness of the triplet interaction, it can be concluded that a bound hypernucleus Σ^-nn very likely does not exist. Using the results obtained in this investigation, speculations are also made concerning the double-Σ hypernuclear systems $\Sigma^-\Sigma^-n$ and $\Sigma^-\Sigma^-nn$. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 5579.

5404 (NYO-3399-37) $\tilde{U}(12)$ AND CROSSING SYMMETRY. Musto, R.; O'Raifeartaigh, L.; Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). Aug. 9, 1965. Contract AT(30-1)-3399. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In view of a paper which throws some doubt on the compatibility of crossing symmetry and $\tilde{U}$ invariance, the question of their compatibility is examined in detail. It is found that crossing symmetry and $\tilde{U}$ invariance are not incompatible. On account of some disagreement in the literature regarding the definition of crossing symmetry, its definition, and its relation to the substitution law are also discussed in detail. (auth)

5405 RELATIVISTIC ELEMENTARY PARTICLE STATES OF AN INTERNALLY STRUCTURED MODEL. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 662-4(Sept. 1966).

Unitary irreducible representations of the Poincaré group realized by a previous model, which gives a relativistic theory of a structure having internal polarization, are presented in order to represent each elementary particle state in some lower levels. This shows how the relativistic treatment of an arbitrarily moving particle with an internal configuration can be consistently performed on a quantum mechanical basis and also in what manner each solution is equivalent to that obtained from the usual abstract representation theory of the Poincaré group. In principle the method is quite general. It is also shown that the kinematical structure allows zero-mass states to be represented conveniently. (J.F.P.)

5406 MULTIPLICITIES IN WEIGHT DIAGRAMS. McConnell, James (St. Patrick's Coll., Maynooth, Ireland). Proc. Roy. Irish Acad., Sect. A, 65: No. 1, 1-12(May 1966).

The properties of weight diagrams of the B_2 Lie group are studied in detail, and rules for finding multiplicities are derived. It is shown how they are related to Wigner's rule for multiplicities in SU(3) weight diagrams. (auth)

5407 UNITARITY, CAUSALITY, AND FERMI STATISTICS. Feldman, G.; Matthews, P. T. (Imperial Coll. of Science and Tech., London). Phys. Rev., 151: 1176-80(Nov. 25, 1966).

Conventionally, Poincaré-invariant S-matrix elements are constructed from auxiliary field operators, which transform like representations of an auxiliary group. Invariance with respect to the index transformations of this group may be extended to couple spin to internal symmetry properties in a covariant manner, as in $\tilde{U}(12)$ and SL(6,C) theories. It is shown that such an index invariance of the S matrix is compatible with unitarity only if the auxiliary operators are unitary representations of the auxiliary group. It is shown further that local fields transforming as such unitary representations can be made causal only if they satisfy commutation (not anticommutation) relations. Thus for index-invariant theories, a direct incompatibility is established between unitarity and causality for Fermi particles. (auth)

5408 SOME CONSEQUENCES OF AN INTRINSIC MASS FORMULA. Bernstein, Herbert J.; Halpern, Francis R. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-Gen-10. Phys. Rev., 151: 1226-8(Nov. 25, 1966). (UCSD-10P10-4).

The requirements that are placed on a relativistically invariant theory by the assumption that single-particle states with different masses are included in the same multiplet are examined. This assumption implies first that the Lie algebra of the symmetry group which includes the generators of both the Lorentz and internal transformations must also have an infinite number of other elements, and secondly, that the direct product of any two single-particle multiplets is irreducible. (auth)

Applications (Electromagnetic and Weak)

5409 ON ISOTOPIC INVARIANCE OF CP-NONINVARIANT ELECTROMAGNETIC VERTICES. Okun, L. B. Phys. Lett., 23: 595-6(Dec. 5, 1966).

The isotopic selection rules are discussed in the framework of a scheme of strong CP violation proposed by Lee. (According to this scheme the charge conjugation operators C_π and C_γ leaving invariant strong and electromagnetic interactions, respectively, do not coincide with each other.) It is shown that in this scheme CP-noninvariant vertices describing the emission of photons by ordinary hadrons must be necessarily isotopically invariant ($\Delta I = 0$) independent of whether the principle of minimal electromagnetic interaction is applicable to so called a-particles and whether these particles are isotopic singlets. (auth)

Application (Strong)

5410 (AEC-tr-6807) TESTS OF THE CONSEQUENCES OF UNITARY SYMMETRY IN HADRON PRODUCTION REACTIONS. Dolgov, A. D.; Solov'ev, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translation of report No. 333. 90p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In the discussion of the consequences of unitary symmetry in hadron production, dynamic effects of interactions which split the mass of the supermultiplets on the amplitudes of the interactions are not considered, and symmetry violation is included only in relations connecting the square of the matrix element with the cross section. Certain statements of unitary symmetry and ways in which one can establish the unitary invariant principles are briefly described. Meson–baryon interactions with the respective production of the octet of baryons and decuplet of baryon resonances, proton–antiproton pair annihilation, SU(3) predictions for baryon–baryon scattering in S states, meson (f^0) production assuming that this is a singlet relative to SU(3), and hadron photoproduction are discussed. (J.F.P.)

5411 PERMUTATION SYMMETRY OF THE QUARK FIELDS. Watanabe, Ichio (Tokyo Medical and Dental Univ.). Progr. Theoret. Phys. (Kyoto), 36: 668-70(Sept. 1966).

It is shown that the free and interaction hamiltonians may be classified by the permutation symmetry of the appropriate basic fields. (J.F.P.)

5412 SELF-CONSISTENT DETERMINATION OF COUPLING SHIFTS IN BROKEN SU(3). II. Dashen, R. F.; Dothan, Y.; Frautschi, S. C.; Sharp, D. H. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 151: 1127-58 (Nov. 25, 1966). (CALT-68-78).

In a recent paper, the possibility of dynamical enhancement of SU(3) symmetry breaking in baryon couplings was considered. It was found that certain patterns of symmetry breaking are enhanced and tend to dominate; the results were presented and compared with experiment. The methods by which these conclusions were obtained are explained in detail, and a more complete summary of the numerical results is given. (auth)

5413 STRONG VERTEX ACCORDING TO SL(6,C). Fronsdal, C.; White, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 151: 1287-92(Nov. 25, 1966).

The baryon-meson vertex is calculated to lowest nonvanishing order in momentum transfer, in a relativistic SU(6) theory in which the particles are assigned to unitary (infinite-dimensional) representations of SL(6,C). The coupling 56, 56, 35 contains no arbitrary parameters except for the overall universal coupling strength. All the results are in excellent agreement with experiment. (auth)

5414 SUM RULES FOR COUPLING CONSTANTS IN EXACT AND BROKEN $SU(6)_W$. Gupta, Sachichida Nanda (National Physical Lab., New Delhi). Phys. Rev., 151: 1235-8(Nov. 25, 1966).

The meson-baryon vertex and the decuplet decays are studied within the framework of the exact and the broken $SU(6)_W$ group. The breaking is provided by a W-spin scalar spurion transforming like the I = 0, Y = 0 member of the 35-dimensional adjoint representation of $SU(6)_W$. Twenty-one sum rules are obtained in the broken symmetry. One of these directly relates the $(p,p\pi^0)$ and $(N^{*++},p\pi^+)$ couplings and yields a decay width $\Gamma(N^{*++} \rightarrow p\pi^+) =$ 70 MeV. Another relates the vertices $(Y_1^{*+},\Lambda\pi^+)$ and $(Y_1^{*+},\Sigma^+\pi^0)$, which seems to agree with the latest experiments on Y_1^* decays. One more relation among the observable decuplet decays is the Gupta-Singh sum rule, which is very well satisfied experimentally. Some predictions of exact $SU(6)_W$ seem to disagree with experiment. It is concluded that in the context of three-point functions the predictions of the broken $SU(6)_W$ group are in very good agreement with experiments. (auth)

5415 PHYSICAL REDUCTIONS IN HIGHER SYMMETRIES. Rolnick, William B. (Case Inst. of Tech., Cleveland). Phys. Rev., 151: 1171-5(Nov. 25, 1966).

It is shown that only reductions with respect to particular subgroups occur in a certain class of physical theories of higher symmetry. It is proven that each irreducible representation (except the trivial one) of a simple Lie group of rank three contains representations of different triality of any SU_3 subgroup thus embedded. (auth)

Quantum Field Theories

5416 (NYO-1932-115) INTERACTIONS OF MASSLESS SPINORS IN TWO DIMENSIONS. Dubin, Daniel A. (New York Univ., N. Y. Dept. of Physics); Tarski, Jan (Columbia Univ., New York. Dept. of Physics). [1966]. Contract AT(30-1)-1932. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The interaction of massless spinors with massive vector mesons ($m_0 > 0$) in two dimensions is investigated (the vector meson model). Two definitions of the current are considered, and operator solutions employing auxiliary free fields are constructed. However, the presentation is heuristic in part, and the problem of positive definiteness of the theory is left open. The limit $m_0 \rightarrow \infty$ is easily obtained; it yields the Thirring model. Some complications are indicated in connection with the limit $m_0 \rightarrow 0$, to the Schwinger model. (auth)

5417 PECULIARITY IN THE PERTURBATION THEORY. Troitskii, V. E.; Shirokov, Yu. M. Zh. Eksp. Teor. Fiz., 51: 1413-16(Nov. 1966). (In Russian).

It is shown in the frames of the perturbation theory that the Heisenberg two-particle matrix element $\langle pk|A(x)|p'k'\rangle$ of a neutral scalar field has a singularity when $K \rightarrow \infty$, where $K = p + k - p' - k'$. (auth)

5418 QUASI-ANALYTICAL FUNCTIONALS IN QUANTUM FIELD THEORY. Gachok, V. P. (Inst. of Mathematics, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 168: 1030-2(June 11, 1966). (In Russian).

The problem of moments in quantum field theory was analyzed. The problem is related to the self-conjugated properties of field operators. The study showed that in the case of quasi-analytical functionals the field operators are subjected to self-conjugated closure. Moreover, it is shown that the equation $E_\lambda(f)E_\mu(g) = E_\gamma(f \times g)$ is present in the spectral series $E_\lambda(f)$, $E_\mu(g)$, $E_\gamma(f \times g)$ for the operators $A(f)$, $A(g)$, $A(f \times g)$ respectively. The basis for Neumann ring closure in field theory is thus found. The results may be used to study self-conjugated expansions, other field theory operators, and in statistical physics. (G.O.Y.)

5419 NECESSARY DEPENDENCE OF CURRENTS ON FIELDS THEY GENERATE. Boulware, D. G. (Univ. of Washington, Seattle); Deser, S. Phys. Rev., 151: 1278-86(Nov. 25, 1966).

It is shown that in local (proper) Lorentz-invariant theories involving axial-vector, or tensor currents (conserved or not), the latter must vanish, if they commute at equal times with the fields they generate. The need for explicit field dependence of currents is demonstrated for gradient-coupled spinless and massive spin-one fields, as well as for electrodynamics with minimal or nonminimal coupling. The field-dependence requirement is distinct from that (already needed for free fields) of "spreading points" to make the current operators well-defined. The relation between the two, however, essentially fixes the form of this dependence. Applications are made to partially conserved currents, $\partial_\mu j^\mu = \alpha\varphi$; if j^0 commutes with φ, the latter vanishes. (auth)

5420 GAUGE INVARIANCE AND CURRENT DEFINITION IN QUANTUM ELECTRODYNAMICS. Boulware, David G. (Univ. of Washington, Seattle). Phys. Rev., 151: 1024-37 (Nov. 25, 1966).

In order to study the problems of gauge invariance, Lorentz covariance, and the operator properties of the "Schwinger terms" in the current commutators, spin-½ quantum electrodynamics is written as the limit of a nonlocal theory. The conditions on such a theory are discussed and the nonlocal equations in the case of an external vector potential derived. The gauge-invariant, Lorentz-covariant limit of these equations is then discussed, and it is found that (in the case of spin ½) the "Schwinger terms" are purely c-number. The quantized vector potential is considered by means of a Feynman path integral and its gauge structure determined. It is found that an automatically gauge-covariant theory results and that the c-number character of the Schwinger terms apparently persists. (auth)

5421 ELECTRIC- AND MAGNETIC-CHARGE RENORMALIZATION. II. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Contract AF 49(638)-1380. Phys. Rev., 151: 1055-7(Nov. 25, 1966).

Further evidence for the universality of charge renormalization is derived by examining the photon radiation and the static interaction of prescribed transverse currents. (auth)

5422 ELECTRIC- AND MAGNETIC-CHARGE RENORMALIZATION. I. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Contract AF 49(638)-1380. Phys. Rev., 151: 1048-54(Nov. 25, 1966).

An important question in the field theory of electric and magnetic charge is the relative renormalization of the two kinds of charges. A general view of renormalization, as a scale change introduced in proceeding from the field to the particle level of description, indicates the universality of charge renormalization. This is confirmed by an explicit calculation of the long-range interaction of static charges. (auth)

Scattering Theory

5423 EXTREMAL VALUE OF THE DIFFERENTIAL ELASTIC SCATTERING CROSS SECTION. Arushanov, G. G. Zh. Eksp. Teor. Fiz., 51: 1402-4(Nov. 1966). (In Russian).

A conditional extremum of the differential elastic scattering cross section is found for definite total cross sections. The ratio of the extremal value of the cross section of the backward scattering to its value at 90° increases with the energy rise as a square root of energy in the laboratory system of coordinates (at constant total cross sections). (auth)

5424 ARE THE RESIDUES OF INTERACTION POLES IN THE N/D METHOD A RIGHT MEASURE OF THE FORCES? Daboul, J. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 23: 592-4(Dec. 5, 1966).

It is shown that the residue g_i of the interaction poles are not the right measure for the effect of the forces. A simple example is constructed to clarify this point. The products g_iD_i should be used instead, where D_i are the values of the D function at the positions of the poles. (auth)

5425 FORWARD AND BACKWARD PEAKS AT HIGH ENERGIES. Jin, Y. S. (Brown Univ., Providence). Phys. Rev., 151: 1259-61(Nov. 25, 1966). (NYO-2262TA-127).

Using a high-energy bound such as the Froissart bound or the Kinoshita-Loeffel-Martin bound, the relation between the high-energy growth of the forward (backward) transition amplitude and the existence of the forward (backward) peak in any two-particle reaction A + B → C + D is obtained. Possible improvement of the result is briefly discussed. (auth)

5426 OPERATOR FOR TIME DELAY INDUCED BY SCATTERING. Lippmann, B. A. (DRC Inc., Santa Barbara, Calif.). Phys. Rev., 151: 1023-4(Nov. 25, 1966).

The operator that gives the time delay induced by a scattering process is exhibited explicitly. (auth)

5427 FORMAL THEORY OF n-PARTICLE SCATTERING. II. Weyers, J. (Univ. of Louvain, Belg. Case Inst. of Tech., Cleveland). Contract AT(11-1)-1573. Phys. Rev., 151: 1159-67(Nov. 25, 1966). (COO-1573-2).

Prescriptions are given for constructing S-matrix elements from the general theory of n-particle scattering previously developed. Some simple models based on the separable approximation are discussed and a method for including corrections to this approximation is described. (auth)

Particle Accelerators

5428 (BNL-10813) GENERAL CONDITIONS FOR ACHIEVING PHASE SHIFTS OF π AND 2π BY MEANS OF QUADRUPOLE MULTIPLETS. Regenstreif, E. (Brookhaven National Lab., Upton, N. Y.). Oct. 24, 1966. Contract AT(30-2)-Gen-16. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The general theory is given for formulating analytic conditions for achieving phase shifts of π and 2π by means of magnetic multiplets (mainly quadruplets, quintuplets, and sextuplets) composed of quadrupoles. The thick lens approach is used throughout, and no use is made of the thin lens approximation. (J.F.P.)

5429 (CERN-66-31) PULSED D.C. POWER SUPPLY 16kA, 60 V SCHNEIDER-WESTINGHOUSE. Isch, H. W. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 20, 1966. 29p. Dep. mn.

The power supply for the septum magnets employed for the slow and fast ejection from the CERN Proton Synchrotron straight-sections 58 and 62 is described. The power supply feeds the ejection magnets with dc current pulses of high stability and small ripple. The results of the tests made on the power supply are given. (B.G.D.)

5430 (DESY-66/28) VERMESSUNGSGRUNDLAGEN UND JUSTIERUNG VON EXPERIMENTEN. (Survey Principles and Adjustment of Experiments). Loeffler, Franz (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1966. 40p. (In German). Dep. mn.

The basic parameters for the surveying of the synchrotron and experimental setups are given. The equipment of the surveying team and the methods applied in adjusting the experimental magnets are described. (auth)

5431 (LA-DC-8255) DESIGNING RESONANT CAVITIES WITH THE LALA COMPUTER PROGRAM. Hoyt, H. C. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 17p. (CONF-661021-27). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

Cavity design studies using the LALA computer program are reported. The three studies included are concerned with $\beta = 0.65$ proton linac cavities, $\beta = 1$ electron linac cavities, and the cavity in the coaxitron microwave amplifier tube. (B.G.D.)

5432 (MURA-723) RF PERTURBATION MEASUREMENTS IN LONG LINAC CAVITIES. Owen, C. W.; Radmer, C. A.; Young, D. E. (Midwestern Universities Research Association, Stoughton, Wis.). Oct. 3, 1966. Contract W-31-109-eng-38. 22p. (CONF-661021-24). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

Equipment and procedures are described for measuring the axial accelerating electric field in long linear accelerator standing wave cavities. The method used is the usual one of measuring the change in resonant frequency caused by a small perturbing sphere on the axis of the cavity. This is done by specially developed equipment connected to an on-line digital computer. Readings are taken at millimeter intervals along the axis allowing the fields to be accurately plotted, integrated, and compared. The method is more rapid and accurate than has previously been possible, and analyses can be carried out readily on the data. The equipment has been used on the 50 MeV linac injector for the Zero Gradient Synchrotron at Argonne National Laboratory. The increased knowledge of the axial accelerating electric field obtained with this equipment should allow improved performance of the linac. (auth)

5433 (NYO-3364-21) INDUCED RADIOACTIVITY IN THE COLLIMATOR SYSTEM OF A 31 MeV BROWN BOVERI BETATRON. Stroemme, Aksel (Norsk Radiumhospital, Oslo). [nd]. Contract AT(30-1)-3364. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

It is found that during use some radioactivity is induced in the collimator system of the BBC 31-MeV betatron. Direct handling of the equalizer system is to be avoided because otherwise the doses to the hands can exceed 150–200 mR a day. But if the hands are placed not closer than about 15 cm from the equalizer system, the dose to the hands will not exceed 3–4 mR even on a busy day. If care is taken the radiation hazards due to induced radioactivity after collimator irradiation are of no practical importance. In modern betatrons the collimator system with the field equalizer is safely mounted inside the apparatus and remotely controlled, and there is thus no radiation hazard from the collimator system. (auth)

5434 (SLAC-PUB-217) THE DESIGN OF THE STANFORD 3-GeV ELECTRON-POSITRON STORAGE RING. Rees, John R. (Stanford Linear Accelerator Center, Calif.). Sept. 1966. Contract AT(04-3)-400. 18p. (CONF-660939-1). DTIE.

From International Symposium on Electron and Positron Storage Rings, Saclay, France.

The Stanford 3-GeV storage ring design was revised to incorporate long straight sections having very small values of the vertical β-function at their centers. The beam reaches a minimum in vertical dimension in the center of a 5-meter-long free space for high-energy detectors. The displacement of the equilibrium orbit for off-momentum particles is zero throughout the experimental regions and is unaffected by adjustments of the interaction-region quadrupoles. The rf power provided is 1.3 megawatts. The luminosity ranges from 1.3×10^{32} cm^{-2} sec^{-1} at 3 GeV up to 2.5×10^{33} at 1.3 GeV. The considerations leading to the design will be discussed. (auth)

5435 (TID-23395) PROGRESS REPORT [ON NUCLEAR PHYSICS], AUGUST 1965–JULY 1966. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Contract AT(11-1)-1265. 215p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The performance of the proton linear accelerator is discussed, and brief accounts are given of the experiments performed using the machine. Improvements to both the machine and the experimental instrumentation are outlined. Performance tests on a new 500-keV injector are reported. Work on the tandem Van de Graaff accelerator was concerned with the assembly and installation of the machine and with preparations for experimental work. Work is also reported on elastic and inelastic proton scattering; pickup reactions; isomeric states in nuclei; measurements of the linear accelerator spectrometer; optical model studies; the diffraction model for direct reactions; investigation of analog laws for E-dE/dx systems; properties of bound states of one-particle one-hole nuclei near ^{208}Pb; quasi-elastic scattering; on-line computer operation; particle detection systems electronic instrumentation; and mechanical instrumentation. (S.F.L.)

5436 (UCID-2851) CONCERNING THE SELF FIELDS OF A BEAM OSCILLATING TRANSVERSELY IN THE PRESENCE OF CLEARING-ELECTRODE PLATES. Laslett, L. Jackson (California Univ., Berkeley). Aug. 11, 1966. Contract W-7405-eng-48. 13p. DTIE.

The development of electromagnetic fields generated by an unbunched beam oscillating transversely between a sequence of identical pairs of clearing-electrode plates that cover substantially the full width of a vacuum chamber with resistive walls is reported. The electric termination of each electrode is at the center of its length. The wavelength of the beam oscillation is taken to be large in comparison to the transverse dimensions of the chamber, and expressions are derived for the fundamental component of the fields that produce a transverse force on the oscillating beam. As a simplifying approximation, the charge and current distributions on the transmission-line structure formed by the electrodes are assumed independent of the transverse coordinate. (B.G.D.)

5437 (UCID-15046) PROPOSED HIGH INJECTION RATE, VACUUM-TUBE-MODULATED, 1000A ELECTRON ACCELERATOR. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 15, 1966. Contract W-7405-eng-48. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A general outline and cost estimate of a proposed electron accelerator for the Astron facility are presented. The parameters of the proposed new accelerator are: electron energy, 4 MeV; beam current, 1000 A; pulse length, 0.3 μsec; and repetition rates, 500 kc in burst mode and 2500 pps in CW operation. (B.G.D.)

5438 (UCRL-17133) EXPERIMENTAL PROBLEMS IN THE USE OF A POLARIZED PROTON TARGET. Chamberlain, Owen (California Univ., Berkeley. Lawrence Radiation Lab.).

Sept. 9, 1966. Contract W-7405-eng-48. 18p. (CONF-660918-3). DTIE.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

Experimental problems in the use of polarized proton targets, particularly lanthanum magnesium nitrate (LMN), are discussed. The difficulties are: hydrogen events must be separated from heavy-nucleus events, existing targets tend to be rather thick when measured in radiation lengths, the LMN is easily damaged by radiation, proton polarization need not be the same in all parts of the sample, the absolute degree of target polarization is uncertain by about 10%, targets require a delay each time polarization direction is reversed, and extra personnel are required to operate the target. (B.G.D.)

5439 ADONE: PRESENT STATE OF WORK. Adone, Gruppo (CNEN, Frascati, Italy). Nuovo Cimento (1), 3: Suppl., 501-5 (1965). (In Italian).

The construction program for ADONE for the 450 MeV electron and positron linear accelerator is briefly outlined. The available experimental and theoretical data indicate that the preliminary designs were adequate and construction can proceed with security. (J.S.R.)

5440 CHARGED PARTICLE MOTION IN A HELICAL MAGNETIC FIELD. Khapaev, M. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 123-7(1966). (In Russian).

Linear motion of charged particles in a helical magnetic field was studied using an averaging formulation for the motion equation. The averaging formulation was constructed, and adiabatic invariances were found and applied in the computation of basic parameters for the focusing system. (R.V.J.)

5441 CHARGE DISTRIBUTION OF ^{16}O IONS PRODUCED FROM TANDEM ACCELERATOR. Preikschat, E.; Cramer, J. G. (Univ. of Washington, Seattle). Rev. Sci. Instrum., 37: 1722-6(Dec. 1966). (RLO-1388-7).

In an effort to obtain information about the acceleration of heavy ions in tandem accelerators, the charge state distribution of oxygen ions accelerated in the University of Washington FN tandem accelerator was measured at three terminal voltages and over a range of stripper pressures. It is found that the stripper pressure normally used is below the value required for equilibrium in the charge exchange process, but that at higher terminal voltages the average charge state of the ions can rise above the equilibrium value due to focusing effects in the accelerating tubes. This phenomenon has implications in the use of foil strippers with heavy ion beams. A useful empirical relation for the optimum stripper pressure for a given charge state is obtained. (auth)

5442 NONBOILING LIQUID HYDROGEN TARGET. Jarmie, Nelson (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 37: 1670-1(Dec. 1966). (LA-DC-8106).

A thin 2 mm liquid hydrogen target is described. It operates at conditions away from the boiling curve and can therefore absorb considerable (200 mW) power from an accelerator beam without serious boiling. Construction and operation are discussed and several additional advantages are presented. (auth)

5443 PARTICLE STORAGE RINGS. O'Neill, Gerard K. Sci. Amer., 215: No. 5, 107-16(Nov. 1966).

The colliding-beam principle for studying particle interactions is discussed, and a survey is given of the theoretical and practical development of particle storage rings for high-energy experiments. Brief descriptions are given of the basic design and development of the storage rings at Stanford, Frascati, and CERN. (L.B.S.)

5444 THE 60-MeV GRENOBLE ISOCHRONOUS CYCLOTRON. Sen, N. C. (Centre de Physique Electronique et Corpusculaire, Orsay, France). Indian J. Phys., 40: 294-302 (June 1966).

The 60-MeV variable-energy isochronous cyclotron designed and constructed for the University of Grenoble is described. A general description of the machine along with methods of calculations, operational characteristics, and special features are given. (auth)

5445 MESON FACTORIES. Rosen, Louis. Phys. Today, 19: No. 12, 21-5; 28-31; 33-6(Dec. 1966). (LA-DC-7684).

The design and development of accelerators, called meson factories, which will produce 500- to 1000-MeV nucleons and mesons in beams thousands of times more intense than those from existing machines are considered. Topics discussed include the purposes for the accelerator development and its uses such as the investigation of internucleon forces using nucleon and meson probes, applications to chemistry and particle physics, and also practical applications. Various meson factory designs are described and compared. (J.F.P.)

5446 METHOD FOR STABILIZING THE ELECTRON-ACCELERATING VOLTAGE. Nagaya, Takashi (to Hitachi Ltd.). Japanese Patent 1965-26650. Nov. 19, 1965. Filed Sept. 5, 1962.

In the high voltage stabilizer proposed, the electromagnetic waves, emitted from the electron rays accelerated by means of a high voltage, are detected, and the electrical signal of detection of the electromagnetic waves is fed back to the control for the accelerating high-voltage, thereby giving a high stabilization of the voltage. Claim: It consists of the following: a device for emitting electromagnetic waves from the high-voltage accelerated electron rays; a device for detecting the variation in the wave-length of the electromagnetic waves, corresponding to the variation in the accelerating high-voltage; a device for converting the wave-length variation into an electrical signal; and a device for controlling the accelerating voltage by means of the electrical signal. (NSA of Japan)

5447 PULSED CHARGED-PARTICLE BEAM ACCELERATING DEVICE. Takeda, Koji (to Hitachi Ltd.). Japanese Patent 1965-26518. Nov. 17, 1965. Filed Sept. 30, 1963.

An improved pulsed charged-particle beam accelerator (such as a linear accelerator) is proposed. The improvements achieved in this accelerator are as follows: simplified structure of the coils used in focusing or deflecting a charged-particle beam; reduction in the electric power consumed by the coils; decrease in the heat produced in the coils; elimination of the cooling device for the coils; exclusion of a power source usually used solely for the coils (a power source for other purposes is used in common by the coils); and easy attaching or detaching of the coils to or from the accelerating tube, achieved by the divided construction around the circumference. The accelerator consists of a charged particle source; a device for accelerating the pulsed charged particles; and the coils, installed along the path of accelerated charged particles, which act on the particles. The coils are excited by the pulsed current synchronized with the pulsed charged-particle beam; by the pulsed current, flowing through part of the circuits of a pulsed-power source for injecting the charged particles (from the source) in pulses; and by the pulsed current, flowing through part of the circuits of a power source for activating the high-frequency tube (for accelerating a charged-particle beam). In construction of the coils, the coil is divided in an appropriate number around the circumference. (NSA of Japan)

5448 CHARGED-PARTICLE BEAM ACCELERATING DEVICE. Takeda, Koji (to Hitachi Ltd.). Japanese Patent 1965-25999. Nov. 11, 1965. Filed Oct. 22, 1964.

A charged-particle beam accelerating device, employing high-frequency waves as the means of acceleration, which is small in size and simple in construction is proposed; in this accelerating device, the net accelerating efficiency is also increased beyond those attainable in the conventional similar devices. By embodying the high-frequency wave generator, high-frequency wave transmitting circuits, and high-frequency wave particle accelerating part, which are usually separately installed, the drawback in the size of a beam accelerating device becomes large due to the use of microwave circuits can be eliminated. In the charged-particle beam accelerating device are provided the following: at least two charged-particle beam ejectors; a device which makes at least two groups of charged particles (from the ejectors) pass through the respective passages in the high-frequency wave field. The passage of one group (at least) to be accelerated is located in the relatively low electric field of the said high-frequency field, while that of the other group (at least one group) to be decelerated is in the relatively strong electric field. The former group supplies energy into the high-frequency wave field, and the latter group acquires energy from the same field. (NSA of Japan)

5449 CHARGED-PARTICLE ACCELERATOR. Maekawa, Akitsugu (to Hitachi Ltd.). Japanese Patent 1965-22840. Oct. 8, 1965. Filed Oct. 25, 1963.

A charged-particle accelerator, which is of less cost and more compact than the conventional accelerators, is proposed. This is achieved by eliminating the output radiowave coupler and radiowave absorbing member (usually installed at the end of an accelerating tube), and the reflected-wave removing device by having the acceleration and wave absorption near the end of the accelerating tube. It consists of a charged-particle source, a high-frequency radio-wave source, and an accelerating tube for acceleration of the injected charged-particles. At least a part near the end of the accelerating tube is made from a highly insulating material having a large gas adsorption such as titanium. (NSA of Japan)

5450 METHOD FOR CONSTRUCTION OF AN ACCELERATING TUBE. Hatano, Juichi (to Tokyo Shibaura Electric Co. Ltd.). Japanese Patent 1965-22520. Oct. 5, 1965. Filed Dec. 11, 1962.

A method is proposed in which the metal discs and cylindrical bodies, arranged one after the other, are heated at a high temperature to connect them together for giving an accelerating tube; in this case, unlike in the conventional method, no plating is employed. The accelerating tube, which is thus obtained easily, is smooth on the inner surface and has little contamination, leading to a reduced loss of the microwaves. The metal discs and cylindrical bodies (forming cavity resonators of an accelerating tube with filter circuits) are arranged alternately in series. These discs and cylinders are heated, while pressed against one another, in a vacuum or in an atmosphere of a reducing or neutral gas. Then the metal in both the discs and cylinders diffuse into each other, resulting in the joining of the discs and cylinders. (NSA of Japan)

5451 PARTICLE ACCELERATOR. Matsushita, Masaharu (to Matsushita Electric Industries Co., Ltd.). Japanese Patent 1965-20958. Sept. 17, 1965. Filed Dec. 18, 1964.

A particle accelerator is proposed in which the accelerating tube, its extension, and a target are all contained in a tank, and the spaces between the tank wall and these components are filled with an insulating oil, thereby providing the insulation among the respective accelerating electrodes. The charged particles are accelerated by applying a high voltage to one end of the accelerating tube. In the conventional accelerators of this type, the particle source side (electrons or other ions) is kept at a high potential, the particle source and the accelerating tube are exposed to the atmosphere, and the accelerating-tube extension and a target are earthed to ground. In this type, however, the electrical power required to produce the charged particles or ions must be provided by the use of an insulated transformer or the dynamo installed at the source side must be operated. In addition, the manipulation necessary for adjustment of the particle source must all be done remotely, and because of the exposure to the atmosphere of both the accelerating tube and the particle source, the operation is very dangerous. (NSA of Japan)

5452 BETATRON. Kanamori, Koji (to Shimadzu Seisakusho Ltd.). Japanese Patent 1965-27280. Nov. 30, 1965. Filed Mar. 9, 1964.

An improved electron injector whereby the output of the betatron can be increased is proposed. In this electron injector, not all the accelerated electrons are injected into the circular (betatron) accelerating tube, but they are introduced into it intermittently at the suitable intervals. The total amount of injected electrons is small, compared with the conventional injectors, but on the contrary, the output of the betatron can be increased due to the reduced effect of space charge. In this method, the deflecting plate is impressed at some intervals in the form of pulses. The voltage applied to the plate is very low, 4000 to 10,000 v, in comparison with the high voltage, 40,000 to 100,000 v, of the accelerating voltage, and so the pulse control is easy. The betatron employs the following: an accelerating tube (this is not the betatron tube) with the deflecting plate for injecting electrons into the betatron circular path; a voltage source for supplying accelerating voltage to the electron gun; and a pulsed-voltage source for supplying pulsed voltage to the deflecting plate. Thus, as described above, electrons from the electron gun are injected into the circular accelerating tube intermittently. (NSA of Japan)

5453 PARTICLE ACCELERATOR. Machiyama, Yoshihiko (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1966-799. Jan. 26, 1966. Filed May 2, 1964.

In the particle accelerator proposed, the drawbacks which the conventional similar accelerator with electron irradiation and x-ray (or neutron) generation in the same system has, are removed. That is, this accelerator can provide an electron and an x-ray beam without deflecting it and furthermore without taking it into the atmosphere. It consists of the following: the charged-particle accelerating device; the support body, opposed to the end of the accelerating tube, having the passage of an accelerated-electron beam; a support rod for a target which travels in the direction traversing the passage of an electron beam (adjoining the position of a target, an opening is provided through the support rod for passage of an electron beam); and the bellows installed air-tight covering the space between the support rod and the inner side of the support body. (NSA of Japan)

5454 PARTICLE ACCELERATOR. Machiyama, Yoshihiko (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1966-798. Jan. 26, 1966. Filed May 2, 1964.

In the particle accelerator proposed, the drawbacks of the conventional similar accelerators in which charged-particle acceleration and x-ray (or neutron) generation are achieved in the same system are removed. That is, this particle accelerator can provide an electron or an x-ray (or neutron) beam without deflecting it and furthermore without taking it into the atmosphere. The particle accelerator is provided with the following: a plurality of targets for producing the respective particles by electron irradiation; the support frame for the targets, equipped with a cooling device; and the mechanism for moving the target support so as to position a given target in the path of an electron beam. (NSA of Japan)

5455 METHOD FOR ADJUSTING THE NONUNIFORM MAGNETIC-FIELD DISTRIBUTION FOR A BETATRON. Hattori, Hiroyuki (to Shimazu Seisakusho Ltd.). Japanese Patent 1966-797. Jan. 26, 1966. Filed Apr. 12, 1964.

A method is proposed in which the nonuniform magnetic-field distribution at the time of injection of electrons can be made uniform, thereby increasing the output of the betatron and also simplifying the structure of the magnet. Hollows are cut through the yoke at suitable positions on the line at right angles to the direction of yoke. Into these hollows is inserted an iron core. The uniformity in the magnetic-field distribution at the time of electron injection can be achieved by adjusting the part of iron core which protrudes from the lower side of the yoke, hence the distance from the magnetic pole to the top of the inserted iron core. (NSA of Japan)

5313 STABILITY OF A FULLY IONIZED NON-MAXWELLIAN ELECTRON-ION PLASMA. Draganu, Mircea. Mathematica, 7: No. 1, 5-31(1965). (In French).

An extension was made to the three-dimensional case of the method developed by Pfirsch for the study of the electrostatic stability of an electron–ion plasma, neutral and homogeneous, completely ionized, and with a non-Maxwellian distribution function which can be represented by a Hermitian series of polynomials multiplied by a Gaussian function. (Int. Aero. Abstr.)

Shielding

5314 (AE–252) NOMOGRAM FOR DETERMINING SHIELD THICKNESS FOR POINT AND LINE SOURCES OF GAMMA RAYS. Joenemalm, C.; Malen, K. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1966. 32p. Dep. mn.

A set of nomograms is given for the determination of the required shield thickness against gamma radiation. The sources handled are point and infinite line sources with shields of Pb, Fe, magnetite concrete ($\rho = 3.6$), ordinary concrete ($\rho = 2.3$) or water. The gamma energy range covered is 0.5 to 10 MeV. The nomograms are directly applicable for source and dose points on the surfaces of the shield. They can easily be extended to source and dose points in other positions by applying a geometrical correction. Also included are data for calculation of the source strength for the most common materials and for fission-product sources. (auth)

5315 (NAA-SR-Memo-11790) OPTIMUM LITHIUM HYDRIDE SHIELD VESSEL DESIGN FOR PROTECTION AGAINST METEOROID PUNCTURES. Schulz, R. B. (Atomics International, Canoga Park, Calif.). May 10, 1966. Contract AT(11-1)-Gen-8. 25p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

A meteoroid puncture of a lithium hydride shield vessel will cause degradation of the neutron attenuation properties of the shield, primarily because of hydrogen loss. An analysis was made relating the increase in fast neutron dose rate due to shield vessel meteoroid puncture as a function of mission duration, exposed area, lithium hydride temperature, vessel thickness, and several other factors. The analysis further determines a minimum weight shield, which would consist of a reduced shield vessel thickness and a compensating increased lithium hydride length so that, at the end of the mission life, the design dose rate would be expected. It may result from this analysis that the minimum shield vessel thickness determined by structural requirements is sufficient for meteoroid protection. For shields with temperature gradients that would result in hydrogen loss in preferential areas, a compartmentalized shield is suggested so that these methods may be applied. A discussion of meteoroid protection for the SNAP-8 instrument rated shield is used for an example, and a comparison with the previous design method is included. The conclusion is that a large reduction in shield vessel thickness can be realized for lithium hydride shields by using this method of analysis. (auth)

5316 (SID-64-2037) STUDY OF SPACE RADIATION SHIELDING. Haffner, J. W. (North American Aviation Inc., Downey, Calif. Space and Information Systems Div.). Dec. 1, 1964. 90p.

Three major sources of high-energy nuclear radiation in space (Van Allen belts, solar flares, and galactic nuclei) are discussed, and their spatial, temporal, mass, and energy distributions are quantitatively given. Techniques for calculating the fluxes, rad doses, and Rem doses each produces under various conditions are presented, and the results of several such calculations are listed in tabular form. In addition, the effects these fluxes and doses have upon men and materials, are quantitatively given so that the shielding required for deep space and orbital missions may be readily ascertained. Finally, an example of a deep space mission is presented and analyzed from the standpoint of space radiation shielding. (auth)

5317 (ORNL-tr-1376) CALCULATION OF REFLECTION AND TRANSMISSION COEFFICIENTS OF A SLAB OF A GIVEN MATERIAL FOR THERMAL NEUTRONS: EVALUATION OF THE RADIATIVE CAPTURE GAMMAS (CENTAURE 3 PROGRAM). Brisbois, Jacques; Duco, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-N-564. 64p. Dep. mn. JCL $6.60 fs, $2.12 mf.

A computer program, CENTAURE 3, for the calculation of neutron albedos on a slab of finite thickness by a successive collision method as well as the angular distribution of capture gamma sources produced in the interior of the slab by the incident thermal neutrons is described. The program is in FORTRAN II for the IBM 7094. (D.C.W.)

5318 RADIATION SHIELD. Kyowa, Kogyo-sho. Japanese Patent 1965-28560. Sept. 30, 1965. Filed Nov. 5, 1958.

A radiation shield is proposed for use in reactors, cyclotrons, highly radioactive facilities, etc. Starting with a material of specific gravity over 3.0, composed of 20 wt % of iron and the remaining zinc, lead, etc., shielding blocks are fabricated having either a protrusion in the shape of a trapezoid in cross section, or the corresponding groove. By means of this protrusion and groove, the blocks are piled up engaging each other to form the desired radiation shield. (NSA of Japan)

Solid-State Physics

Refer also to abstracts 4946, 4947, 4984, 5089, 5091, and 5115.

5319 (ARL–66-0149) THEORETICAL INVESTIGATIONS OF THE PENETRATION OF KILOVOLT IONS AND ATOMS IN SOLIDS. Baroody, E. M. (Battelle Memorial Inst., Columbus, Ohio). July 1966. Contract AF33(657)-8853. 46p.

Two distinct problems arising in the theory of ion penetration are discussed. In the first, the Boltzmann transport equation and the method of Mellin transforms are used to calculate moments of the range distribution of particles stopped by elastic collisions in a medium of randomly located target atoms when cross sections are products of factors depending on energy and angle separately. Results are given for inverse power repulsive potentials and, with additional approximations, for Coulomb potentials with Thomas–Fermi screening. The effect of having several kinds of stopping atoms is considered and comparisons with measurements on amorphous WO_3 are included. The representation of range distributions by using moments in an Edgeworth series is also treated. The second problem, the spreading of weak disturbances in crystals, has a bearing on energy loss from focused collision sequences and similar questions. Detailed results are given for the energy loss from a disturbed atom in a simple cubic lattice with central and noncentral forces between nearest neighbors. These include the calculation of additional terms in the expansion which applies at long times. (auth)

5320 (COO–623-115) SOLID STATE PHYSICS PROGRAM. Annual Progress Report. [Smith, Charles S.] (Case Inst. of Tech., Cleveland, Ohio). Nov. 1, 1966. Contract AT(11-1)-623. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

This report, covering the period Nov. 1965, through Oct. 1966, includes abstracts of five technical reports issued, brief descriptions of work still in progress, and an outline of proposals for future research. Reports for which abstracts are given concerned electronic structure of liquid metals, internal stress and annealing of Fe films, pressure derivatives of the elastic constants of CaF_2, and energy gaps in disordered systems. Brief descriptions of work on the following are included: magnetic measurements on thin films, thermal expansion of NaF, elastic constants of RbI at low temperatures, pressure derivatives of the elastic constant of Cu, Bloch electrons in a magnetic field, and valence band structure of diamonds. (A.G.W.)

5321 (LA–3599) AN EQUATION OF STATE FOR IRON ASSUMING AN INSTANTANEOUS PHASE CHANGE. Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Iron undergoes a phase transition at 130 kbar, producing two compressive shocks. This transition can be numerically described in one-dimensional hydrodynamic calculations by using a Grüneisen equation of state to calculate the state points off the Hugoniot. The Hugoniot is described by $U_s = 0.463 + 1.275 U_p$ (where U_s is shock velocity and U_p is particle velocity in cm/μsec) from normal specific volume to 0.1190 cc/gm; the Hugoniot pressure is maintained at 130 kbar between 0.1190 and 0.1148 cc/gm; and between 130 and 440 kbar the Hugoniot is described by $U_s = 0.32 + 2.25 U_p$. This treatment of the Hugoniot of iron assumes that the phase change occurs instantaneously. (auth)

5322 (N–66-29299) RESEARCH ON THE PHYSICS OF SOLID MATERIALS. Semiannual Status Report No. 14, November 1, 1965–April 30, 1966. Brotzen, Franz R. (Rice Univ., Houston, Tex.). 35p. (NASA-CR–75814). CFSTI $3.00 cy, $0.65 mn.

Abstracted data and program objectives are presented for three areas of research in the physics of solid materials: solid-state physics, covering magnetic and electric aspects of materials research; physical metallurgy, concerning metallic materials; and chemistry of solids including chemical reactions and thermodynamics involving solid substances. The solid-state research includes such topics as: spin-lattice interaction in paramagnetic crystals, polarization of stimulated emission of lasers, crystal optics of Mössbauer gamma rays, and radiant energy conversion. Some of the studies in physical metallurgy are: microcreep in b.c.c. metals, electrical resistivity of deformed Mo single crystals, electron microscope facility and thin-film research, and energies and entropies of solute atoms in dilute solid solution. Some of the chemistry of solids topics are: free energy of vacancy formation in solids, modified cell cluster theory, crystal structure of complex molecules, and radiation effects on metallic films and solid surfaces. (TAB)

5323 ELECTRON SPIN RESONANCE IN ELECTRON-IRRADIATED n-TYPE SILICON CARBIDE. **Van Ryneveld, W. P.; Loubser, J. H. N. (Univ. of the Witwatersrand, Johannesburg). Brit. J. Appl. Phys., 17: 1277-83(Oct. 1966).**

The effects of 0.8-MeV electron irradiation on 6H-type hexagonal silicon carbide doped with nitrogen were studied by electron spin resonance and optical absorption methods. After irradiation the optical absorption peak at 16,400 cm^{-1} disappeared and in the ESR spectrum a strong isotropic line, with g value 2.0036 ± 0.0005 as well as six equidistant lines with separation of about 1.4 G and g value 2.0032 ± 0.0005, were observed at room temperature. These lines are probably due to aluminum impurities. On cooling the specimen down to 77°K it was found that the three-line nitrogen spectrum had disappeared and six pairs of anisotropic lines were observed. These were found to be fine structure lines with spin $S = 1$, $D = 0.052 \pm 0.002\ \mathrm{cm}^{-1}$, $g_{\perp} = 2.010 \pm 0.001$ and $g_{||} = 2.005 \pm 0.001$. After heating the crystal to 200°C, the six pairs of lines disappeared and the three nitrogen lines were partially restored. Furthermore, two lines with separation of about 18 G were observed at room temperature. These lines are probably due to hyperfine interaction with the ^{29}Si nucleus or with an impurity, e.g., ^{31}P, with nuclear spin $I = \frac{1}{2}$. After repeated heating and annealing of the crystal at higher temperatures, the nitrogen ESR spectrum was restored, but the line intensities were now sensitive to light of wavelength 11,000 Å. A model is put forward to explain these effects. (auth)

5324 METHOD OF CALCULATING THE ENERGY SPECTRUM OF AN ELECTRON IN THE FIELD OF MANY POTENTIALS. **Hirota, Toru (Shibaura Inst. of Tech., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 488-503(Sept. 1966).**

The Schroedinger equation for an electron moving in the field of many potentials is expressed as a kind of difference equation in the approximation that the distances between the centers of adjacent potentials are much larger than the range of a potential. This procedure is exact when the range of the potential approaches zero. By solving the difference equation, an explicit formula for the energy spectrum is obtained which contains a lattice sum of the kind treated first by Ewald. The merit of the method lies in the fact that the potential part is separated from the lattice-structure part as far as possible, and the treatment of the electronic state in the array of many potentials is correspondingly simplified. (auth)

5325 ABSORPTION OF A NARROW BEAM OF BREMSSTRAHLUNG WITH A MAXIMUM ENERGY OF 200 keV IN ALKALI–HALIDE SINGLE CRYSTALS. **Vorob'ev, V. A. (Kirov Polytechnic Inst., Tomsk, USSR). Soviet Phys.-Cryst. (Engl. Transl.), 11: 355-6(Nov.-Dec. 1966).**

Translated from Kristallografiya, 11: 398-400(May-June 1966).

The absorption of bremsstrahlung in KCl, KBr, and KI single crystals was studied as a function of the sample thickness taking into account the change in spectral composition of the radiation as the latter passes through the crystals. (auth)

5326 EXPANSION OF QUARTZ CAUSED BY IRRADIATION WITH FAST NEUTRONS. **Zubov, V. G.; Ivanov, A. T. (Lomonosov State Univ., Moscow). Soviet Phys.-Cryst. (Engl. Transl.), 11: 372-4(Nov.-Dec. 1966).**

Translated from Kristallografiya, 11: 422-4(May-June 1966).

On the assumption that the predominant type of process occurring during the irradiation of quartz is the formation of submicroscopic amorphous regions accompanied by a variation in the surrounding crystal lattice, an analytical expression was derived for the dependence of the relative expansion of quartz on the integrated flux of fast neutrons which is in good agreement with the experimental data. (auth)

5327 INCOHERENT SCATTERING OF NEUTRONS AND THE PROBLEM OF RECONSTRUCTING THE MAGNON SPECTRUM. **Izyumov, Yu. A.; Medvedev, M. V. Zh. Eksp. Teor. Fiz., 51: 1423-9(Nov. 1966). (In Russian).**

A method is developed for determining the state density in the magnon spectrum of a ferromagnetic crystal on basis of data pertaining to inelastic scattering of neutrons. It is shown that measurement of the scattered neutron energy distribution should not be carried out for a perfect ferromagnetic crystal but for a crystal containing a small concentration of nonmagnetic substitution atoms. It is found that in this case the cross section defined by the incoherent single-magnon scattering impurities can be expressed in terms of the density state in the magnon spectrum of a perfect crystal. (auth)

5328 NEUTRON DIFFRACTION IN A POLARIZED CRYSTAL. **Baryshevskii, V. G. Zh. Eksp. Teor. Fiz., 51: 1587-91(Nov. 1966). (In Russian).**

Due to difference of energies existing between the states of a neutron with the spin directed along the target polarization and opposite to it, it is possible to obtain a resonance reorientation of the neutron spin while applying an alternating magnetic field. Several resonance frequencies are obtained in contrast to the case when there are no diffracted waves in the crystal. (auth)

5329 X-RAY PRODUCTION OF VACANCIES IN PURE AND DOPED KCl AT 4.2 DEG K. **Behr, A.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 23: 620-2(Dec. 12, 1966).**

The production of α and F centers by x rays in KCl of different dislocation densities and impurities at 4.2°K is studied. The concentration of the vacancies generated at 4.2°K is constant. (auth)

5330 ATOMIC DISPLACEMENT IN PYROLYTIC GRAPHITE BY ELECTRON BOMBARDMENT. **Iwata, T.; Nihira, T. (Japan Atomic Energy Research Inst., Tokyo). Phys. Lett., 23: 631-2 (Dec. 12, 1966).**

The uniaxial anisotropy of the threshold energy for atomic displacements, the displacement cascade process and the electrical resistivity of Frenkel pairs in well-annealed pyrolytic graphite were investigated from the electrical resistivity change due to electron bombardment in the energy range 0.13 to 1.0 MeV. (auth)

5331 EFFECT OF INTERACTION OF NUCLEAR SPINS WITH SPIN WAVES ON QUADRUPOLE SPLITTING OF NMR LINES. **Kurkin, M. I.; Parfenova, N. G. (Inst. of Metal Physics, Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 1460-4 (Dec. 1966).**

Translated from Fiz. Tverd. Tela, 8: 1839-46(June 1966).

A study is made of NMR in antiferromagnets whose antiferromagnetic axis lies in the basal plane, account being taken of quadrupole interaction and of the interaction of nuclear spins with spin waves. (auth)

5332 RESEARCH ON MAGNETISM USING NEUTRON DIFFRACTION. **Paoletti, A. (CNEN, Casaccia, Italy). Nuovo Cimento (1), 3: Suppl., 667-75(1965). (In Italian).**

The use of neutron diffraction techniques for determining magnetic properties, detailed reproduction of the distribution function of magnetic electrons, and determination of form factors is illustrated. (J.S.R.)

5333 F' AND M' TRAPS IN ALKALI HALIDES STUDIED BY MEANS OF PHOTOSTIMULATED THERMOLUMINESCENCE. **Scaramelli, P. (Univ., Milan). Nuovo Cimento (10), 45B: 119-31(Oct. 11, 1966).**

The nature of some traps in NaCl, KCl, and KBr is investigated by means of correlated experiments on photostimulated thermoluminescence and optical absorption. The glow peaks centered at 149°K in KBr and at 340°K in NaCl are due to the thermal release of F′ electrons; the activation energy E and the frequency ν_0, characteristic of the F′ glow peaks in NaCl, KCl, KBr are: $E_{F'}$ (NaCl) = (0.91 ± 0.06) eV, $E_{F'}$ (KCl) = (0.537 ± 0.005) eV, $E_{F'}$ (KBr) = (0.35 ± 0.01) eV; $\log \nu_0$ (NaCl) = 12.3 ± 0.5, $\log \nu_0$ (KCl) = 11.4 ± 0.2, $\log \nu_0$ (KBr) = 11.1 ± 0.3. Furthermore, comparison of photostimulated thermoluminescence measurements with optical absorption at the maximum of the M band strongly suggests that the traps which are responsible for the glow bands at 228 and 241°K in NaCl are due to M′ centers. (auth)

Theoretical Physics

Refer also to abstracts 5031 and 5385.

5334 (AD–637151) COVARIANT NOETHER IDENTITIES IN COVARIANT FIELD THEORIES. **Ray, John R. (Illinois Univ., Urbana. Coordinated Science Lab.). July 1966. Contract DA-28-043-AMC-00073(E). 15p. (R–305). CFSTI $3.00 cy, $0.65 mn.**

In covariant field theories such as general relativity the application of Noether's theorem results in a set of identities which are satisfied regardless of whether the field equations are satisfied or not (so-called strong conservation laws). In the conventional formulation these identities contain nontensorial quantities and non-tensorial operations. Thus, for example, the energy-momentum-pseudo-tensor of general relativity is obtained from such formulations. The identities arising from Noether's theorem are written in an obviously covariant form containing only tensors and covariant derivatives. As an example these identities are given for general relativity. (auth)

5335 (NP-16395) GEODESIC MOTION IN GRAVITATIONAL FIELDS. I. INTERNAL SCHWARZSCHILD FIELD. Kuchowicz, Bronislaw (Warsaw Univ. (Poland). Dept. of Radiochemistry). Apr. 1966. 35p. Dep.

The motion of a test body with given mass, energy, and angular momentum in an incompressible fluid sphere was studied in the framework of general relativity. Conditions for the physical parameters of the test body were derived under which the trajectory is of a closed type. It was found that for some choice of the physical parameters there exist two regions wherein particle motion is possible. These two regions form two completely separated domains. The results may be applied either to motion of elementary particles in superdense stars or to motion of celestial bodies in galaxies. (auth)

5336 SPECIFIC HEAT OF A RELATIVISTIC DEGENERATE ELECTRON GAS. Hamada, Tetsuo; Nakamura, Yosiaki (Ibaraki Univ., Mito, Japan). Progr. Theoret. Phys. (Kyoto), 36: 465-72(Sept. 1966).

The specific heat of a relativistic degenerate electron gas is calculated. The result is $c/c_0 = [1 + Ae^2 + Be^2 \ln e^2 + 0\,(e^4 \ln e^2)]^{-1}$ with

$$A = -\frac{1}{2\pi\sqrt{1+x^2}}\left\{\frac{2}{x} + \frac{1}{x}\ln\left(\frac{\sqrt{1+x^2}}{\pi x} + \frac{2}{\pi}\right) + x\left(1 - \ln\left|\frac{1}{2} - \frac{1}{2x\sqrt{1+x^2}} \times \sinh^{-1} x\right|\right) - \left(\frac{3}{\sqrt{1+x^2}} + \frac{2}{x}\right)\sinh^{-1} x\right\}$$

and $B = -[2\pi x\sqrt{1+x^2}]^{-\frac{1}{2}}$, where $x = k_F/m$ is the relativity parameter and c_0 is the specific heat of a relativistic noninteracting gas. The present work may be regarded as a relativistic generalization of Gell-Mann's nonrelativistic calculation. (auth)

5337 ON THE DISCRETE EIGENVALUES OF THE MANY-PARTICLE SYSTEM. Uchiyama, Jun (Kyoto Univ.). Publ. Res. Inst. Math. Sci., Ser. A, 2: 117-32(Aug. 1966).

A system in a static magnetic field which consists of N electrons and M infinitely heavy nuclei is considered. The Schroedinger operator in nonrelativistic quantum mechanics is described. Discrete eigenvalues were found. (M.O.W.)

5338 STUDIES IN THE THEORY OF THE GENERALIZED DENSITY OPERATORS. I. FOUNDATIONS. Brandstatter, J. J.; Peltzer, C. (Stanford Research Inst., Menlo Park, Calif.). J. Math. Anal. Appl., 16: 123-37(Oct. 1966).

A systematic development is presented of a previous theory which will provide a sound basis for further theoretical studies of many-body problems and for applications of these concepts to solid state-physics and quantum chemistry. Particular emphasis is placed on precise definitions of the spaces and operators introduced and on a rigorous mathematical development. (J.H.M.)

5339 CYLINDRICALLY SYMMETRIC ELECTROMAGNETIC FIELDS OF CLASS ONE. Sharan, R.; Tiwari, R. N. (Banaras Hindu Univ., Varanasi, India). Proc. Nat. Inst. Sci. India, Pt. A, 31: 465-76(Sept. 1965).

A search was made for solutions of the electromagnetic field equations which are of class one. A nonstatic cylindrically symmetric metric of class one obtained by introducing a function ψ of ρ and t in the flat metric in cylindrically polar coordinates is considered. The metric is found to be incompatible with electromagnetic distribution. By assuming two of the eigenvalues equal, two solutions were obtained. A similar procedure is adopted by taking ψ as a function of ρ and z. Two types of electromagnetic fields resulting from the consideration of the Rainich algebraic relations for the most general cylindrically symmetric metric of Marder are subjected to the necessary and sufficient conditions for a Riemannian fourfold to be of class one. The solutions obtained correspond to electromagnetic wrenches, in the terminology of flat space-time, along one of the spatial coordinate lines. The electromagnetic fields are uniform and the corresponding Riemannian fourfolds are the products of two surfaces of constant curvatures. (auth)

5340 QUASI-ENERGY OF A QUANTUM SYSTEM SUBJECTED TO A PERIODIC ACTION. Zeldovich, Ya. B. Zh. Eksp. Teor. Fiz., 51: 1492-5(Nov. 1966). (In Russian).

The structure of the solutions of the Schroedinger equation for a quantum system subjected to a classical force which is a periodic function of time is considered. The concept of quasi energy of quasi-stationary states which vary periodically in time is introduced. The radiation from a system consisting of single quanta with frequencies which are multiples of the external field frequency or of groups of quanta which are related to radiative transitions from one quasi-stationary state to another, and in particular, from the lower to an upper state at the expense of the energy of the external field, is considered. (auth)

5341 PULSATING COLLAPSE FROM THE POINT OF VIEW OF AN EXTERNAL OBSERVER. Gertsenshtein, M. E.; Aivazyan, Yu. M. Zh. Eksp. Teor. Fiz., 51: 1405-12(Nov. 1966). (In Russian).

An oscillating collapse as viewed in the coordinate system of an observer located outside a pulsating sphere of constant density is considered. It is shown that for an external observer the shell of the pulsating sphere is always located within the R region, i.e., outside the Schwarzschild sphere. The oscillation period for an external observer is given by formula. In the Schwarzschild coordinate system time is real in the R region and has a constant imaginary additional term in the T region. The Schwarzschild coordinate system is unique in vacuum outside the pulsating sphere. Ambiguity and the imaginary time contribution arise only within matter for which the Schwarzschild metric is invalid. The picture seen by an external observer is discussed. It is shown that compression-expansion symmetry in such a picture is violated. (auth)

5342 SCREENING CONSTANTS FOR RELATIVISTIC WAVE FUNCTIONS. Garstang, R. H.; Mayers, D. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Proc. Cambridge Phil. Soc., 62: 777-82(Oct. 1966).

Formulas for the mean radius and mean square radius of a relativistic Coulomb wave function are obtained. Screening constants for the energy, mean radius, and mean square radius are defined relative to nonrelativistic wave functions and the results of numerical calculations given. It is shown that if the screening constants so determined are added to the screening constants due to the presence of other electrons as found by the s.c.f. method, good agreement is obtained in a case where both effects have been considered together. The value of solving the relativistic wave equation in a Thomas-Fermi field is also shown. (auth)

5343 HIGH ORDER FREQUENCY SHIFT MEASUREMENT AND GENERAL RELATIVITY. Richard, J.-P. (Univ. of Maryland, College Park). Nature, 212: 601-2(Nov. 5, 1966).

In the theory of general relativity, the path of the photon is described as a null geodesic. If the field is static, this implies that the path of the photon obeys a Fermat principle of least time, the speed of the photon being given by $d\sigma/dt = C\sqrt{g_{44}}$, where $d\sigma$ is the relativistic spatial line element; t the coordinate time; g_{44} the time component of the metric; and C the speed of the photon in the absence of a gravitational field. It is pointed out that the general relativistic effect contained in the equation gives rise to a high-order frequency shift. (W.D.M.)

5344 SCHWINGER FUNCTIONS AND THE CLASSICAL LIMIT OF EQUILIBRIUM QUANTUM STATISTICAL MECHANICS. Symanzik, K. (New York Univ., New York). Nuovo Cimento (10), 45B: 269-72(Oct. 11, 1966).

Since quantum mechanics unifies the particle and wave picture of matter, QSM unifies the statistical mechanics of particles and of wave fields, as is most directly seen in the formalism of second quantization. It is therefore to be expected that there exists a classical limit of QSM in which CSM not of particles but of wave fields emerges. It is shown here that this is the case at least in thermodynamic equilibrium, and the precise conditions for this limiting behavior to result in model cases of reduced number of dimensions are discussed. This limit is not of interest for the physical systems hereby considered, since practically and theoretically unrealizable conditions must be imposed. However, from the reduced density matrices in a suitable limit the Schwinger functions (Euclidean Green's functions, i.e., Feynman amplitudes continued analytically from real to imaginary times) of certain relativistic local quantum field theories are obtained. (M.O.W.)

5345 NOTE ON OPERATOR CALCULUS IN QUANTUM MECHANICS. Arthurs, A. M. (Univ. of Wisconsin, Madison). Nuovo Cimento (10), 45B: 256-8(Oct. 11, 1966).

Fuchs earlier introduced a modification of the standard operator calculus of quantum mechanics to take account of the finite domain (the atomic polyhedron) of the wave functions. The criterion employed was that if A denotes the set of wave functions ψ for which the Hamiltonian operator is self-adjoint, an operator calculus may be obtained by admitting all operators which map the set A into itself. Fuchs found, on using certain periodic boundary conditions, that the momentum operator P represented by $-i\partial/\partial q$ is an admissible operator, but that the position operator Q represented by q is not then admissible. To get around this difficulty Fuchs replaced q by an operator ξ equal to the Fourier development of q, together with certain surface operators. However, an alternative operator calculus can be developed. It is based on the choice of a more general representation of the momentum operator. The operator calculus is described. (M.O.W.)

5346 NONZERO-MASS GRAVITON AND FLAT BACKGROUND IN GENERAL RELATIVITY. Droz-Vincent, Ph. (Institut Henri Poincare, Paris). Nuovo Cimento (10), 45B: 245-8(Oct. 11, 1966).

As Rosen earlier pointed out, the introduction of a flat-space metric along with the ordinary metric tensor $g_{\mu\nu}$ leads to some improvements in the formalism of general relativity. A general relativity is now proposed, with mass term, where no flat metric is necessary to write down the field equations, though a flat metric occurs when one solves these equations. (M.O.W.)

5347 ON THE SELECTION OF NONLINEAR SPINOR EQUATIONS. Chepurnykh, G. K. Vestn. Moskov. Univ., Ser. III: Fiz. Astron., No. 3, 82-4(May-June 1965). (In Russian).

Before examining the nonlinear equations for the quantum case, the classical equation derived from the Lagrangian $L = I_1 - mI_0 + W$ was considered. W, I_1, and I_0 are invariant with respect to time inversion and possess solution only under certain specified conditions with respect to both positive and negative energies. The equation for the quantum case was derived from the above. The invariance of the Lagrangian toward strong reflections requires that the spinor field be quantized only by anticommutators, and the scalar and vector fields by commutators. Thus, all of the known transforms of the linear theory may be applied unchanged to the nonlinear case. (TTT)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

5348 ELECTRON SCATTERING ON NUCLEONS AND NUCLEI. Hofstadter, R. (Stanford Univ., Calif.). Nuovo Cimento (1), 3: Suppl., 568-85(1965).

Recent studies made at Stanford on electron scattering on nucleons and nuclei are briefly described. All studies discussed were made with the Stanford Linear Electron Accelerator, whose operation is briefly considered. Results obtained in the study of the nucleon, the ^{40}Ca nucleus, and the upper limit of the electric dipole moment of the electron. (J.S.R.)

5349 SUMMARY OF THE NATIONAL ACTIVITY IN THE FIELD OF HIGH ENERGY. Moneti, G. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (1), 3: Suppl, 759-810(1965). (In Italian).

Research in the high energy field in Italy is briefly summarized under the classifications of strong interaction studies, electromagnetic interactions and nucleon form factors, and double interactions. Under strong interactions meson and baryon resonances and their characteristics, models of interaction by the exchange of a single particle, elastic interactions at very high energy, and other strong interactions such as nucleon-antinucleon and strange particle reactions. Some general considerations on the future of high energy studies in Italy are given. (J.S.R.)

5350 180 DEG POSITRON–ELECTRON SCATTERING AT 200 AND 500 MeV. Browman, A.; Grossetete, B.; Yount, D. (Ecole Normale Superieure, Orsay, France). Phys. Rev., 151: 1094-1107(Nov. 25, 1966).

To test the predictions of quantum electrodynamics, absolute and relative measurements of the positron–electron scattering cross section were made at 200 and at 500 MeV. Recoil electrons were detected with the spectrometer at 0° with respect to the incident-beam direction, and for the range of recoil momenta studied, the elastic-scattering cone was entirely contained in the angular acceptance of the spectrometer. This method permitted high precision and an experimental test of the radiative corrections. The absolute accuracy of the cross sections was 1%. The complete radiative corrections for this experiment are not yet available. However, for purposes of orientation, existing calculations may be extrapolated to the present situation. Then the shape of the recoil spectrum near the incident positron momentum is consistent with the theory if the radiative corrections of the form $1 + \epsilon$ are used (χ^2 probability of 0.5); the shape is in less good agreement if the correction has the form e^{δ} (χ^2 probability of 0.2). The most precise measurements made, where the corrections were about 15%, were in agreement with the theory. The accuracy has to be increased to decide between e^{δ} and $1 + \delta$. If radiative corrections are assumed to be precisely known, the experiment determines 1/K to about 0.6 F, where a violation of quantum electrodynamics of the form $\sigma \rightarrow \sigma_0(1-q^2/K^2)^2$ is assumed, and where σ is the quantum-electrodynamical cross section and q is the four-momentum transfer. A significant increase in sensitivity could be achieved by extending the experiment to available positron energies well above the relatively modest values used. (auth)

5351 TEST OF C INVARIANCE IN THE 3π DECAY MODE OF THE η MESON. Larribe, A. (CEN, Saclay, France); Leveque, A.; Mueller, A.; (and others). Phys. Lett., 23: 600-4(Dec. 5, 1966).

$\eta \rightarrow 3\pi$ decays were studied in a D_2-filled bubble chamber and their Dalitz plot shows a right-left asymmetry $A = -0.061 \pm 0.040$ consistent with C invariance. (auth)

Weak

5352 $\Sigma^{\pm}$ LIFETIME AND THE BRANCHING RATIO $B_{\Sigma^+} \equiv (\Sigma^+ \rightarrow \pi^+ + n)/(\Sigma^+ \rightarrow \text{ALL})$. Chang, C. Y. (Columbia Univ., New York). Phys. Rev., 151: 1081-9(Nov. 25, 1966).

Using 11,000 charged Σ's produced from $K^- + p \rightarrow \Sigma^{\pm} + \pi^{\mp}$ interactions taking place in the 30-in. Columbia-BNL hydrogen bubble chamber, the $\Sigma^{\pm}$ lifetimes and the branching ratio $B_{\Sigma^+} \equiv (\Sigma^+ \rightarrow \pi^+ + n)/(\Sigma^+ \rightarrow \text{all})$ were determined. By means of a least-squares fit to the differential decay distributions for the in-flight sigma decays, the following values were obtained: $\tau_{\Sigma^+} = (0.830 \pm 0.018) \times 10^{-10}$ sec, $\tau_{\Sigma^-} = (1.666 \pm 0.026) \times 10^{-10}$ sec, and $B_{\Sigma^+} = 0.46 \pm 0.02$. (auth)

5353 MEAN LIFE OF THE π^0 MESON. Stamer, P.; Taylor, S.; Koller, E. L.; Huetter, T.; Grauman, J.; Pandoulas, D. (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 151: 1108-16 (Nov. 25, 1966).

An estimate of the π^0 mean lifetime was obtained from a sample of 232 $K^+_{\pi 2}$ ($K^+ \rightarrow \pi^+ + \pi^0$) decays at rest. The π^0's were detected by the Dalitz mode ($\pi^0 \rightarrow e^+ + e^- + \gamma$), and the decay distances from the K^+ ending to the π^0 decay points were measured. These events were found in an area scanning of an emulsion stack of 600-μm Ilford G5 emulsion pellicles exposed to a 400 MeV/c separated K^+ beam. The observed mean π^0 lifetime is $(1.0 \pm 0.5) \times 10^{-16}$ sec. (auth)

Strong (Baryon-Induced)

5354 A REMARK ON 30 GeV JET SHOWERS. Hasegawa, S. (Waseda Univ., Tokyo); Kawamura, T. Uchusen-Kenkyu, 10: 655-66(Dec. 1965).

Six Ilford G-5 emulsion sheets of 2 in. × 4 in. × 600 μ, exposed to a Brookhaven 30.5-GeV/c proton beam were studied in detail. The correlation among the secondary mesons, namely, the azimuthal asymmetry in the angular distribution of generated mesons in the jet showers, was first examined statistically under the conditions of N_h 0 or 1 and $N_s > 4$, where N_h is the number of slow evaporation tracks, and N_s the number of secondary relativistic particles. The asymmetry factor $Z_0 = (n_f - n_b)/(n_f + n_b)$ was calculated from 65 jet showers, and it was found that 10 events with $n_s \geq 7$ and 28 events with $n_s \geq 11$ were $|Z_0| \geq 0.5$. The nuclear recoil transverse momentum $P_{TN} \approx (1 - K)M\gamma_L \sin\theta_N$, excluding survived protons, was studied by Yajima-Hasegawa method, where $K = K_L$ and θ_N is the deflection angle in LS for the incident nucleon, and $K = K_M$ and θ_N is the one in MS for the target nucleon. It appeared that a real correlation was existent between P_{TN} and K. It was concluded that the statistics were not sufficient to clarify the above problems from the viewpoint of event number. (NSA of Japan)

5355 REMARKS ON THE INTERACTIONS OF 14-GeV PROTONS WITH NUCLEONS. Csejthey-Barth, M. Bull. Inst. Phys. Univ. Libre Brux., No. 28, 1-12(Oct. 1966). (In French).

The momentum distribution of secondary protons in the center of mass system is studied along with the production of charged π and K mesons. The interpretation of the experimental results that is presented here forms part of a larger attempt to understand proton-nucleon interactions at 14 GeV in nuclear emulsions. (G.O.Y.)

5356 STUDY OF THE POLARIZATION OF ANTIPROTON IN $\bar{p}p$ SCATTERING AT 1.18 GeV/c. Dobrzynski, L. (College de France, Paris); Ghesquiere, C.; Xuong, Ng. H.; Tofte, H. Phys. Lett., 23: 614-16(Dec. 5, 1966).

Analysis of 2764 double scattering events of antiprotons at 1.18 GeV/c in the 81 cm Saclay hydrogen bubble chamber yields an asymmetry of $(-2.3 \pm 3)\%$ for the angular region $15° \leq \theta_{cm} \leq 60°$, with an average angle $\theta_{cm} = 28°$. This would correspond to an upper limit of 20% for the polarization of the antiproton at 95% confidence limit. (auth)

Strong (Meson-Induced)

5357 η PRODUCTION NEAR THRESHOLD. Jones, W. G. (Imperial Coll. of Science and Tech., London); Binnie, D. M.; Duane, A.; Horsey, J. P.; Mason, D. C.; Newth, J. A.; Rahman, I. U.; Walters, J.; Horwitz, N.; Palit, P. Phys. Lett., 23: 597-600(Dec. 5, 1966).

A study of $\pi^- + p \rightarrow \eta + n$ near threshold shows that the cross section rises linearly with η momentum and that $\Gamma_\eta < 0.9$ MeV/c^2 (95% confidence limit). (auth)

5358 THE ANGULAR DISTRIBUTION OF BACKWARD ELASTICALLY SCATTERED PIONS AT 3.55 GeV/c. Baker, W. F. (CERN, Geneva); Carlson, P. J.; Chabaud, V.; (and others). Phys. Lett., 23: 605-9(Dec. 5, 1966).

The elastic scattering of 3.55 GeV/c π^+ and π^- mesons by protons was measured at center-of-mass angles between 165 and 177°. The angular distributions for 864 events show a steeply rising backward peak for π^+p, while the shape is less clear for π^-p. (auth)

5359 POLARIZATION OF THE Σ^0 AND THE Λ PARTICLES PRODUCED IN THE REACTION $\pi^- + p \rightarrow K^0 + \Sigma^0$ (Λ) AT 1.17 AND 1.32 GeV/c. Kim, Young S. (Ohio State Univ., Columbus); Burleson, G. R.; Kalmus, P. I. P.; Roberts, A.; Sandler, C. L.;

Romanowski, T. A. Phys. Rev., 151: 1090-3(Nov. 25, 1966). (COO-1545-9).

The polarization of the Σ^0 and Λ particles in the reaction $\pi^- + p \rightarrow K^0 + \Sigma^0\ (\Lambda)$ was measured at 1.17 and 1.32 BeV/c, using a spark-chamber–magnet system. Both polarizations are substantial and their angular distributions are clearly dependent on the beam momentum. (auth)

Particle Interactions and Properties (Theoretical)

General

5360 GENERAL THEORY OF DISPERSION SUM RULES WITH SPECIAL EMPHASIS ON THE HIGH-ENERGY CONTRIBUTION. Muzinich, I. J. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Rev., 151: 1206-14(Nov. 25, 1966).

A covariant technique to extract the useful sum rules contained in the current commutation relations at equal times has been developed by Fubini. This technique is used to derive the independent sum rules at finite momentum transfer from the SU(3) current algebra. In particular, the sum rules are derived coming from the commutator of a vector current with its time component where the particles on the outside of the commutator have spin $\frac{1}{2}$. The high-energy contribution to the sum rules is discussed in terms of the Regge poles of the crossed channel. The Regge representation relevant to the kinematics of the amplitude is treated in detail. The contributions of terms in the commutator other than the usual canonical result are shown to be related to dispersion sum rules more singular at high energy than the usual sum rules. Such contributions are the so-called Schwinger terms. (auth)

5361 EQUATIONS FOR THE AMPLITUDES OF COMPLEX PARTICLE PROCESSES IN SIMPLE MODELS. PART II. Pazdzerskii, V. A. (Tashkent State Univ., USSR). Izv. Akad. Nauk Uz. SSR. Ser. Fiz.-Mat. Nauk, No. 4, 32-4(1966). (In Russian).

A linear equation for inelastic scattering of identical particles was obtained using a system of equations binding the elastic and exchange amplitudes. (R.V.J.)

5362 STUDY OF A COMPOSITE PARTICLE MODEL. Houard, Jean-Claude (College de France, Paris). Can. Phys., 20: 161-228(May-June 1966). (In French).

Composite particle theories, which are defined by the cancellation of a renormalization constant, are studied on the basis of a soluble example. The consequences of this cancellation are investigated especially insofar as they concern the observable differences that may allow one to distinguish an elementary particle from a composite particle. The two basic models studied are Lee's model, which allows for three elementary particles V, N, θ interacting in a Yukawa coupling that permits both reactions $V \rightleftharpoons N\theta$; and another model where N and θ are elementary while V is a composite particle and the only allowable interaction $N\theta \rightarrow N\theta$ results from a Fermi-type coupling. It is shown that the condition for equivalence between these two models is precisely the cancellation of the renormalization constant. It is further shown that, from a certain point of view, elementary as well as composite particles must be treated in the same fashion insofar as the properties of their propagators are concerned. The investigation is then extended in both models to the case $V\theta \rightleftharpoons N\theta\theta$ and the matrices for this process are diagonalized. The parallel between the elementary and the composite particle is then completed by putting the calculations in the framework of perturbation theory. The scattering amplitudes for $V\theta \rightleftharpoons N\theta\theta$ are calculated using theory and some possible uses for these amplitudes are given. (G.O.Y.)

Electromagnetic

Refer also to abstract 5402.

5363 (AD–637210) NEUTRON FORM FACTOR. Chilton, Frank; Uhrhane, F. J. (Stanford Univ., Calif. High-Energy Physics Lab.). June 1966. Contract AF 49(638)-1389. 15p. (HEPL–454). CFSTI $3.00 cy, $0.65 mn.

A functional form for G_n is found which gives an explanation of why $G_n(t) \approx 0$ but $G_n(0)$ does not = 0. (auth)

5364 FORM FACTORS AND MULTIPOLES IN ELECTROMAGNETIC INTERACTIONS. Dubovik, V. M.; Cheshkov, A. A. Zh. Eksp. Teor. Fiz., 51: 1369-73(Nov. 1966). (In Russian).

The electric and magnetic multipoles of the first and second kind are determined for arbitrary spin particles. The electromagnetic current operator is parametrized in terms of the particle multipoles and their average 2n-power distribution ranges. The properties of the current operators under conditions when P and T invariance is imposed are discussed. (auth)

5365 PRYCE THEOREM AND NEUTRINO THEORY OF PHOTONS. Berezinskii, V. S. Zh. Eksp. Teor. Fiz., 51: 1374-84(Nov. 1966). (In Russian).

Recently some possibilities were found and widely discussed which apparently helped to avoid the difficulty shown by Pryce in the neutrino theory of photons. It is shown in the general form for free fields and any N-particle states that the requirements of invariance with respect to spatial relations and true neutrality are incompatible for a compound photon (Pryce theorem). The evidence given covers all the constructions proposed recently. (auth)

5366 NEW METHOD FOR SOLVING THE CASCADE THEORY EQUATIONS. Vaskin, A. I.; Guzhavin, V. V.; Ivanenko, I. P. Zh. Eksp. Teor. Fiz., 51: 1483-91(Nov. 1966). (In Russian).

A new method for solving the equations of electromagnetic cascade theory is described in detail. The method is based on substitution of a simple approximate differential operator for the integral operator describing the electron bremsstrahlung and pair production processes. Some results obtained by employing the method for solving the unidimensional cascade theory equations, in which ionization losses are or are not taken into account, are presented. (auth)

5367 COMMENTS ON INTENSITY-DEPENDENT FREQUENCY SHIFT IN COMPTON SCATTERING AND ITS POSSIBLE DETECTION. Fried, Z.; Baker, A.; Korff, D. (Lowell Technological Inst., Mass.). Phys. Rev., 151: 1040-8(Nov. 25, 1966).

It is shown that the Hamiltonian of an electron coupled to an external radiation field is not Hermitian within the space of Volkov solutions with scattering boundary conditions. This is demonstrated by explicitly showing that the inner product of two states which are asymptotically orthogonal to each other fails to vanish at a finite time. It is further demonstrated that if the momentum operator is Hermitian within the (asymptotically) free-electron states, it fails to be Hermitian within the fully developed Volkov states. Consequently the parameters p and p′ entering into the Volkov solution with scattering boundary conditions cannot be interpreted as the momenta of the incident and emerging electron, respectively. The only consistent use of the Volkov solutions is for nonscattering situations, viz., the emission or absorption of a photon by an electron which is never decoupled from the external field. In the latter case the parameters p and p′ which enter into the energy-momentum conservation formula refer to average initial and final electron momenta. A consistent interpretation requires us also to compute the dispersion in the electron momenta. On this basis a dispersion is also obtained in the scattered frequency, a physically detectable quantity, which is much larger than the intensity-dependent frequency shift. On the basis of general quantum principles, it is also demonstrated: (a) that the Feynman–Dyson S-matrix technique is the correct procedure to use inasmuch as it gives agreement with energy-momentum conservation and unitarity, (b) that Kibble's explanation of energy-momentum conservation is incompatible with quantized perturbation theory, and (c) that in the case of external transverse fields the perturbation expansion yields a polynomial in the field strength. An experiment involving frequency mixing is suggested as a means of obtaining a maximum effect in the "beat" frequency due to the nonlinearity parameter ν^2. (auth)

5368 DOUBLE-PHOTON CONTRIBUTIONS TO MULTIPLE-PHOTON PROCESSES. Cohan, Norah V.; Hameka, Hendrik F. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 151: 1076-80(Nov. 25, 1966).

It is shown that in evaluating the transition probability of a multiple-photon process involving more than two photons, the contributions of the part of the interaction Hamiltonian that is quadratic in the vector potential of the radiation field may be neglected if the vector potential of the radiation field is assumed to be constant in the region of space considered. (auth)

5369 PHENOMENOLOGICAL ANALYSIS OF $K^+\Lambda$ PHOTOPRODUCTION. Thom, H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 151: 1322-36(Nov. 25, 1966).

Low-energy $K\Lambda$ photoproduction cross-section and polarization data are analyzed using contributions from nonresonant perturbation amplitudes associated with p, K^+, Λ, Σ, and K^{*+} propagators, and from a resonant amplitude in one total and final orbital angular momentum state. The resonance is assumed to have an energy of about 1.7 GeV and a width of about 100 MeV. The data are analyzed by assuming that the resonance can be in any one of the angular momentum states from $S_{\frac{1}{2}}$ to $F_{\frac{1}{2}}$, and a χ^2 minimization is performed for each possibility. It is found that the perturbation amplitudes alone give good fits to the cross-section data, and that only a small amount of resonant amplitude in any one of a number of angular momentum states is sufficient to explain the polarization without strongly modifying the cross-section fits. The assumed resonant state in general contributes about 20% to the total cross section, and $P_{\frac{1}{2}}$ and $D_{\frac{1}{2}}$ states give the lowest values of χ^2. The values of the coupling constants obtained herein are compared with those expected from SU(3); approximate agreement is found though the values obtained in the analysis are generally smaller than the SU(3) predictions. The possible contribution of an $F_{\frac{1}{2}}$ resonant amplitude found in the analysis is consistent with that expected from SU(3) for the third resonance. A compilation of all the presently existing KΛ photoproduction data is given as an appendix. (auth)

5370 MODIFIED ANALYSIS OF NUCLEON ELECTROMAGNETIC FORM-FACTOR DATA. Kane, G. L. (Univ. of Michigan, Ann Arbor); Zdanis, R. A. Phys. Rev., 151: 1239-43(Nov. 25, 1966).

It is suggested that the usual procedure for analyzing nucleon electromagnetic form-factor data be modified by retaining in a suitable manner the dispersion-integral contributions present even after removal of known vector-meson contributions. This allows a more general analysis consistent with all known restrictions on the form factors. The form factors are parametrized and the parameters determined by comparison with experimental data. It is possible to obtain reasonable fits to all of the data with a total of two parameters. The resulting form factors are suitable for the extraction of useful numbers, including the residues at the known vector-meson poles. In addition, analytic continuation to the annihilation region is well-defined and allows meaningful comparison with data there. It is not necessary to make statements about the existence of vector mesons other than ρ, ω, φ. The results are used to discuss the ρ dominance of the isovector form factor and to estimate the vector-meson– nucleon coupling constants. (auth)

Weak

5371 (AD-637252) FADDEEV EQUATIONS FOR THE K TO 3π AMPLITUDE. Barbour, I. M.; Schult, R. L. (Illinois Univ., Urbana. Dept. of Physics). 1966. Contract Nonr-1834(05). 52p. CFSTI $3.00 cy, $0.65 mn.

Integral equations for the three pion decay amplitude of the K-meson are derived in the context of a potential scattering model. Non local S- and P- wave separable potentials are used. Some numerical solutions are presented. The shapes of the decay spectra are found to be independent of the potential. The connection with the integral equations of Khuri and Trieman is discussed. A zero range approximation requires that A exp 2_2 > A exp 2_0 data. Some aspects of three body states in the presence of a resonance are investigated. No observable effects of a triangle singularity are found for the cases considered. (auth)

5372 POSSIBLE SCHEME FOR THE NONLEPTONIC DECAYS OF HYPERONS. II. Kaneko, Takao (Meijo Univ., Nagoya, Japan). Progr. Theoret. Phys. (Kyoto), 36: 598-606 (Sept. 1966).

On the basis of the $[\chi\bar{\theta}]$ model for baryons and the assumption that two-body transitions among the hypothetical triplet χ_α are forbidden, sum rules are derived without using the SU(3) symmetry, for the nonleptonic decays of hyperons which coincide with the Sugawara-Lee relation and the relation derived previously in the unitary symmetry limit. Then an attempt is made to derive the $|\Delta I| = \frac{1}{2}$ rule in two ways, by applying the Okubo-Marshak-Sudarshan theory and by using the results recently derived by Sugawara and Suzuki. Some relations between the decay amplitudes which are essentially equivalent to the $|\Delta I| = \frac{1}{2}$ rule can be derived. (auth)

5373 MODEL OF WEAK INTERACTIONS OF BARYONS AND LEPTONS. Arbuzov, B. A.; Filippov, A. T. Zh. Eksp. Teor. Fiz., 51: 1389-1401(Nov. 1966). (In Russian).

A model is considered in which weak interactions of two fundamental fields (lepton and baryon fields) are created as a result of the change of the space-time structure at small distances. Universality of weak interactions in the Cabibbo from, the selection rule $|\Delta S| \leq 1$ for all decays and the rule $\Delta S = \Delta Q$ for lepton decays are obtained as a result of the main assumptions made in the model. (auth)

5374 SUM RULES IN HYPERNUCLEAR BETA DECAY. Kim, C. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 151: 1261-6(Nov. 25, 1966).

Sum rules relating axial-vector coupling constants for hypernuclear beta decay, $G_A({}_\Lambda N_i \rightarrow N_f)$, to integrals over kaon energy of kaon–final-nucleus total cross sections, $\mathcal{I}(K^\pm,N_f)$, are obtained by generalizing the previous work on sum rules in nuclear beta decay to hypernuclear beta decay. It is shown that the ratio $\mathcal{I}(K^\pm,N_f)/[Z\mathcal{I}(K^\pm,p) + (A - Z)\mathcal{I}(K^\pm,n)]$ becomes unity in the approximation of neglect of meson-exchange corrections to $G_A({}_\Lambda N_i \rightarrow N_f)$, as in the case of the analogous expression containing $\mathcal{I}(\pi^\pm,N_f)$, $\mathcal{I}(\pi^\pm,p)$, and $\mathcal{I}(\pi^\pm,n)$ in nuclear beta decay. (auth)

5375 NEUTRINO PAIR PRODUCTION IN BOUND–BOUND TRANSITIONS. Steigman, Gary (New York Univ.). Phys. Rev., 151: 1189-91(Nov. 25, 1966).

The lifetime of an atomic state against decay induced by the lepton part of the weak interaction is computed. Lifetimes against such decay, in which neutrino-antineutrino pairs are emitted, are extremely long ($\sim 10^{35}$ to 10^{40} sec in hydrogen). Despite a very strong dependence on atomic number ($\sim Z^{13}$ for the 2P → 1S transition) the power radiated in neutrinos is very small ($\sim 10^{-5}$ erg/ gm^{-1} sec^{-1} for iron). In the temperature and density range relevant for this process other neutrino processes are quite small and optical luminosity serves as the major energy loss mechanism for a star. (auth)

5376 DYNAMICS OF THE WEAK INTERACTION $\Lambda N \rightarrow NN$. Kumar, Rajendra; Dass, Guru Vachan (Univ. of Delhi). Phys. Rev., 151: 1244-50(Nov. 25, 1966).

An attempt was made to understand the spin and isospin dependence of the weak interaction $\Lambda N \rightarrow NN$ as determined by Block and Dalitz from a phenomenological analysis of the nonmesonic decays of the light hypernuclei ${}_\Lambda He^4$ and ${}_\Lambda H^4$. The calculation is an extension of the pole model used by Lee and Swift for nonleptonic hyperon decays. The CP-invariant weak Hamiltonian was taken to transform like λ_6, a member of the octet representation of SU(3). One-boson-exchange forces were considered for the strong-interaction part; SU(3)-symmetric meson-baryon couplings were used. The weak scalar-pseudoscalar-meson pole was introduced in addition to the vector–pseudoscalar-meson pole for the parity-violating channel. For the parity-conserving channel, scalar-meson exchanges were also introduced in addition to (a) the pseudoscalar and the vector-meson exchanges for the weak-baryon pole diagram, and (b) the weak pseudoscalar-pseudoscalar-meson pole diagram. The results are in fair agreement with the deductions of Block and Dalitz. (auth)

5377 LOW-ENERGY THEOREM FOR THE WEAK AXIAL-VECTOR VERTEX. Adler, S. L.; Dothan, Y. (California Inst. of Tech., Pasadena). Phys. Rev., 151: 1267-77(Nov. 25, 1966). (CALT-68-73).

A low-energy theorem is derived for the weak axial-vector vertex. The theorem enables one to calculate from strong or electromagnetic processes the two leading terms in the expansion of the axial-vector vertex in powers of the leptonic four-momentum transfer. Applications to weak pion production, K_{e4} decay, and radiative μ capture are discussed. In particular, the radiative μ-capture matrix element, up to and including contributions linear in the leptonic four-momentum transfer and the photon four-momentum, are expressed in terms of the elastic weak form factors and pion photoproduction amplitudes. (auth)

5378 APPLICATION OF CURRENT COMMUTATION RULES TO $\Delta Q = 0$, $\Delta S = 1$ DECAY MODES OF HADRONS. Tanaka, K. (Ohio State Univ., Columbus). Contract AT(11-1)-1547. Phys. Rev., 151: 1203-6(Nov. 25, 1966). (COO-1545-7).

The reduction in strength of the order of $f^2 \approx 10^{-4}$ due to the strong interactions that characterize the $\Delta Q = 0$, $|\Delta S| = 1$ decay modes such as $\Sigma^+ \rightarrow p + \gamma$ is obtained from the S-wave nonleptonic decay amplitudes. A weak-interaction Hamiltonian for nonleptonic S-wave decay that transforms like the 7th component of the space integral of the pseudoscalar quark density is assumed. Then, the algebra of current commutation relations of scalar, pseudoscalar, and axial-vector currents, and the partially conserved axial-vector current relation are used to relate the S-wave amplitude of $\Sigma^+ \rightarrow p + \pi^0$ to the weak vertex $\Sigma^+ \rightarrow p$. Extension of the present technique to the decay mode $K^+ \rightarrow \pi^+ + e^+ + e^-$ is also discussed. (auth)

5379 THEORY OF NEUTRAL LEPTONIC CURRENTS. Good, M. L.; Michel, L.; de Rafael, E. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Phys. Rev., 151: 1194-1202(Nov. 25, 1966).

d'Espagnat's theory of weak interactions is extended to include neutral leptonic currents. It is found possible to obtain agreement with the experimental absence of neutral lepton currents in all processes involving hadrons in a natural way, but only by introducing $i \equiv \sqrt{(-1)}$ multiplying the entire leptonic Lagrangian. It is also found natural to couple the μ leptons and the e leptons in symmetrical, but different, ways. The consequences of the coupling scheme, in addition to the sought-for absence of most neutral currents, are: (1) separate conservation of μ and e leptons, (2) a mechanism for the $\mu - e$ mass difference, and (3) production of μ pairs in e-type neutrino scattering and in μ scattering. If, in addition, the decoupling of hadronic and leptonic neutral currents which were set up is broken by any small perturbation, CP violation results. The experimental consequences of two such possible symmetry-breaking mechanisms are discussed. (auth)

5380 AXIAL-VECTOR CURRENT CONSISTING OF PSEUDOSCALAR OCTET. Kuo, T. K.; Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 151: 1181-6(Nov. 25, 1966).

The boson part of the axial-vector current which satisfies the SU(3) × SU(3) commutator algebra is constructed in terms of the pseudoscalar fields alone. This axial-vector current consists of linear and triple terms in the pseudoscalar fields, all of which are linear in their space-time derivatives. It is shown that there is no octet of such a current which can be constructed in terms of the pseudoscalar octet alone. In fact, no such octet satisfies even the SU(2) × SU(2) portion of the algebra. However, an octet of the axial-vector current can be constructed in terms of the pseudoscalar octet and a pseudoscalar singlet. This axial-vector current satisfies the U(3) × U(3) commutator algebra and is the only current of this kind. Even when the pseudoscalar-singlet part of the current is dropped, this axial-vector current can maintain the SU(3) × SU(3) algebra or the SU(2) × SU(2) algebra in two limits of possible interest. The most general axial-vector current of this type which satisfies the SU(2) × SU(2) algebra is also constructed in terms of the members of the pseudoscalar octet. (auth)

5381 STATUS OF WEAK INTERACTION PHYSICS. Zichichi, A. (CERN, Geneva). Nuovo Cimento (1), 3: Suppl., 894-933(1965). (In Italian).

The present status of weak interaction physics is characterized by the progress made in the comprehension of the following problems: lepton numbers and the corresponding selection rules, new principle of universality and the introduction of SU_3 in weak interactions, the $\Delta I = 1/2$ selection rule and the neutral current, form of weak interactions, the induced pseudoscalar term g_p, the pion structure, neutrino physics, and the decay of K_2^0 into two pions. The most significant developments made in each of these fields are discussed. (J.S.R.)

5382 SYMMETRY PROPERTIES OF THE STATE VECTORS OF TWO UNSTABLE PARTICLES. Jaus, W. (Univ., Zurich). Helv. Phys. Acta, 39: 617-40(1966). (In German).

The statistical behavior of unstable particles is examined. For this purpose the state vector of the unstable V-particle in the Lee model is constructed and its dependence on the excitation condition shown. The state vector of two unstable V's no longer obeys the symmetrization postulate (SP) and the violation of SP is a consequence of the fact, that the V's can decay. As an example of the technique a caculation is made, again in a simple model of the probability, that the long-lived component of K^0 decays into a 2π-state via a CP-invariant decay interaction. This probability measures the deviation from SP of the state vector of two unstable π's, but because it is very small it is concluded that in present experiments the π behaves like an exact boson. (auth)

Strong (General)

5383 (AD-637560) CALCULUS FOR A BOOTSTRAP DYNAMICS. Bastin, Edward W. (Cambridge Language Research Unit (England)). Jan. 1965. Contract AF-EOAR-78-65 32p. (AFOSR-66-0415). CFSTI $3.00 cy, $0.65 mn.

An outline and conceptual basis are presented for a calculus in which the elements are a finite set of similar entities capable of undergoing interactions, and the process of bringing two elements into consideration together constitutes a new element that is of the same kind as the original ones and is capable itself of being brought into consideration with the members of the first set. The elements form a hierarchy and under certain conditions can be simply ordered so that the sets are finite and their order calculable. The simple ordering is used to describe a bootstrap system for interactions between particles and to define the physical quantity of time. A relationship between levels in the hierarchy expresses the recursive nature of each decision by using the total possible number of decisions at each level as the algebraic basis for the set at the next more complex level. The system accounts for dynamic processes in terms of discrete interactions. Its nonformal expression is related to concepts of information transfer. (auth)

5384 (INR-732/VII/PH) SYMMETRIC THREE-QUARK INTERACTIONS. Werle, J. (Institute of Nuclear Research, Warsaw (Poland)). June 1966. 12p. Dep.

A simplified treatment of three-quark interactions is proposed. It is based on the nonrelativistic three-particle Hamiltonian which is invariant under the group O_8. Such a symmetry implies that the strongest interactions between quarks are essential three-body interactions. Two-body interactions break O_8 and are responsible for the mass splitting which is two orders of magnitude smaller. The proposed O_8 symmetry simplifies considerably the discussion of energy levels. (auth)

5385 SOME ASPECTS OF RECENT RESEARCH DONE IN ITALY IN THEORETICAL PHYSICS. Verde, M. (Univ., Turin). Nuovo Cimento (1), 3: Suppl., 1071-80(1965). (In Italian).

The nature of theoretical research is divided into two parts. In one group methods dominate the study of classical and quantum kinematics. In the other part the problems of quantum dynamics of collisions in the presence of strong interactions are considered. The most recent research done in Italy in each of these areas is discussed. (J.S.R.)

5386 SOME CONSEQUENCES OF AN INTEGRAL REPRESENTATION FOR THE RENORMALIZATION FUNCTION $Z_3(s)$. Rockmore, Ronald (Rutgers—The State Univ. of New Jersey, New Brunswick). Phys. Rev., 151: 1228-34(Nov. 25, 1966).

An integral representation for the renormalization function, $Z_3(s) = \Delta_F(s)/\Delta_{F'}(s)$, and hence for the composite eigenvalue conditions $Z_3(\infty) = 0$, $\lim_{s\to\infty} sZ_3(s) = 0$ as well, is derived. The representation allows for the possible emergence onto the physical sheet of Castillejo—Dalitz—Dyson (CDD) poles, as the coupling strength increases, by satisfying the requirements of analytic continuation in that parameter. The composite conditions are obtained in a relativistic scalar model (in the elastic approximation) and in a one-pole nonrelativistic model; in confirmation of a surmise due to Ida, these conditions are found manifestly independent of the position of the CDD poles. Applications of the representation to some limit problems in the theory of noncomposite particles, to the Zachariasen model, and to a multichannel generalization of that model are made. The extension of the representation to the nucleon is the basis for a brief numerical analysis of $Z_N(w)$ and related quantities in the one-branch approximation. (auth)

Strong (Baryon No. = 0)

5387 CURRENT ALGEBRA AND ω-ϕ MIXING PARAMETER. Gupta, K. C. (Center for Advanced Study in Theoretical Physics and Astrophysics, Delhi). Phys. Rev., 151: 1250-2(Nov. 25, 1966).

Assuming the current-generated algebra and the partially conserved axial-vector current condition for the strangeness-changing axial-vector current, an attempt is made to relate the F/D ratio parameter f with the ω-ϕ mixing angle. It is concluded that the Adler—Weisberger type of sum rule obtained gives results consistent with previous work. (auth)

5388 TWO-CHANNEL CALCULATION FOR THE ρ MESON BY THE EFFECTIVE-POTENTIAL METHOD. Vaidya, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 151: 1192-3(Nov. 25, 1966).

The width and the mass of the ρ meson are calculated in the coupled $\pi\pi$-$K\bar{K}$ problem, using an effective potential in a Schroedinger equation to unitarize the input. It is found that the coupling to the closed $K\bar{K}$ channel has a considerable narrowing effect on the ρ resonance. The calculation is free of any arbitrary parameter such as cutoffs or the subtraction points. With about 10% self-consistency $m_\rho \approx 5.5$ pion masses and the reduced width ≈ 0.36 are obtained. The effect of f^0 was also included to obtain the reduced width ≈ 0.215 and mass ≈ 4.6. The width of the ρ comes out considerably smaller than in the usual calculations. (auth)

Strong (Baryon No. = 1)

5389 (NYO-2262-103) π-N PHASE SHIFTS FROM PARTICLE EXCHANGES AND ELASTIC UNITARITY. Islam, M. M.; Pinon, R. (Brown Univ., Providence, R. I. Dept. of Physics). Aug. 16, 1965. Contract AT(30-1)-2262. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Within the framework of analyticity, elastic unitarity, and single particle exchange forces, low energy p, d, f, and g wave π-N phase shifts are calculated using a recently suggested approximation technique. N, N*, ρ, and $\sigma(I = 0, J = 0, \pi$-π resonance) exchange forces only are considered. The masses and coupling constants of these particles are taken as known quantities. Results are compared with some of the current πN phase shift analyses. (auth)

5390 NUCLEON EXCHANGE AND THE FREQUENCY DISTRIBUTION OF THE TREIMAN-YANG ANGLE. Bussian, A. E. (High Altitude Observatory, Boulder, Colo.). Phys. Lett., 23: 591-2(Dec. 5, 1966).

A point regarding the frequency distribution of the Treiman–Yang angle associated with the nucleon exchange graph is clarified. The reactions $\pi^- + p \rightarrow n + \pi^+ + \pi^-$ and $\pi^- + p \rightarrow p + \pi^0 + \pi^-$ are considered in the π^- n rest frame. It is shown that one of the conditions for a restriction on the Treiman–Yang frequency distribution does not necessarily follow from the nucleon exchange graph. (J.F.P.)

5391 AN ATTEMPT AT SYSTEMATIZING MESON-BARYON RESONANCES. Otsuki, Shoichiro; Sawada, Shoji (Kyushu Univ., Fukuoka. Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 666-8(Sept. 1966).

A model is proposed which may systematize the level scheme of baryon or meson-baryon resonances. It is based on the assumptions that most of the baryon resonances are well described as composite systems of a low-lying baryon and meson and that the Kycia–Wiley rule can be extended in the manner given. It is examined to what extent the given molecular structure holds in the series of Y = 1 baryon resonances. (J.F.P.)

5392 PION–NUCLEON BACKWARD SCATTERING AT HIGH ENERGIES AND PION STRUCTURE. Namiki, Mikio; Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 36: 568-97(Sept. 1966).

By using the impulse approximation under the assumption that the pion can be regarded as a composite system of a nucleon and an antinucleon, the pion-nucleon scattering amplitudes at high energies are written down in terms of the nucleon-nucleon scattering amplitude, the nucleon-antinucleon scattering amplitude and the nucleon-antinucleon bound state wave function. Some backward peaks in pion-nucleon scattering are naturally expected to come from the forward peaks in nucleon-nucleon and nucleon-antinucleon elastic scattering through the exchange or rearrangement effect. This type of backward peak is called the "exchange backward peak." There the probability of finding a nucleon-antinucleon pair in the pion state becomes the only free parameter to be adjusted so as to fit the theoretical curves to the experimental plots. With appropriate values of the probability it is shown that the experimental angular distribution of the $\pi^{\pm}p$ elastic backward cross sections at about 4 GeV/c (of the incident pion momentum in the laboratory system) are well reproduced by the theoretical "exchange backward peak" with the right order of magnitude and the correct forms — including the difference between the backward behavior of π^+p and π^-p scattering. The angular distribution in pion-nucleon scattering at about 8 GeV/c is also obtained with the right order of magnitude, although the statistics of the experiments is too unsatisfactory to compare with the theoretical one in the backward region. Finally it is pointed out that the sharp backward peaks of the $\pi^{\pm}p$ elastic scattering should not originate in the simple "exchange backward peak" but in the backward behavior of the nucleon-antinucleon amplitude coming from the no-pair intermediate states and of the proton-neutron scattering coming from the charge-exchange effect. The sharp forward peak π^-p charge exchange scattering may also be due to the same source. It is shown that the sharp backward peaks cannot be understood by the correction terms from the u-channel resonances unless special form factors are used with a broad range and a small magnitude. (auth)

5393 INTERFERENCE OF REGGE ρ EXCHANGE WITH DIRECT CHANNEL FERMION RESONANCES. Barger, V.; Olsson, M. (Univ. of Wisconsin, Madison). Phys. Rev., 151: 1123-6 (Nov. 25, 1966). (COO–881-71).

Using a Reggeized ρ-meson-exchange background amplitude, information on Y = +1 fermion resonances is obtained from a calculation of the energy dependence of (i) the difference of the π^-p and π^+p total cross sections and (ii) the $\pi^-p \rightarrow \pi^0n$ differential cross section at zero degrees. Some evidence is found for a new $I = \frac{1}{2}$ resonance at 3350 MeV that might be a further Regge recurrence of the N_γ trajectory. Study of the charge-exchange data confirms the validity of the Regge prediction for the phase of the background amplitude. (auth)

5394 BOOTSTRAP MODEL OF BARYONS WITH NONDEGENERATE MESONS. Lin, K. Y. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 151: 1319-22(Nov. 25, 1966). (CAR–882-19).

A static bootstrap model of baryons including N, N*, Σ, Λ, Y_1^*, π, and K is considered. The mass difference between the mesons is treated as a parameter. One solution is found which produces strong attractions in several channels expected to be free from bound states, and which therefore seems not self-consistent. Besides, the mass spectrum of this solution differs from the experimental results. It is concluded that the heavier baryons (Ξ, Ξ^*, and Ω), and perhaps also the η, are necessary for self-consistency. (auth)

5395 SPIN-DENSITY-MATRIX ANALYSIS. POSITIVITY CONDITIONS AND EBERHARD–GOOD THEOREM. Minnaert, Pierre (Centre de Physique Theorique, Paris). Phys. Rev., 151: 1306-18(Nov. 25, 1966).

The conditions that the positive-definiteness of the spin density matrix implies on its multipole parameters are derived. The general conditions imposed by the Eberhard–Good theorem are also derived. General formulas are given for arbitrary spin j, and detailed results are worked out for j = 1 and $j = \frac{3}{2}$. Some applications of these results to spin determination are considered. (auth)

5396 SPIN EFFECTS ON TRIANGLE GRAPHS. Month, Melvin (Univ. of Illinois, Urbana). Phys. Rev., 151: 1302-5(Nov. 25, 1966).

It is shown that the triangle amplitude can be written as the scalar graph multiplied by a factor which contains only the characteristics of the external particles. In the case where the spins of the external particles are summed, their angles averaged, and only one partial-wave set (that is, a set of relative orbital angular momenta among the final-state particles) retained, this multiplicative factor is just a product of appropriate 3-momenta. The case $K^+p \rightarrow K\pi\pi p$ at 3 BeV/c is considered; and it is demonstrated that the correct inclusion of threshold factors does not diminish the effect calculated in our earlier work, where the shape of the "κ enhancement" was successfully described by a triangle graph. (auth)

5397 SELF-CONSISTENT THREE-BODY CALCULATION OF PION–NUCLEON SCATTERING. Aaron, Ronald (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 151: 1293-1302(Nov. 25, 1966).

Using an off-energy-shell static theory which treats three-particle unitarity exactly, but neglects left-hand cuts, the low-energy P-wave $N\pi$ system is described. A well-satisfied "bootstrap" requirement in the (3,3) channel and a possible explanation for the Roper resonance in the (1,1) channel are obtained. (auth)

5398 DYNAMICAL MODEL FOR BARYON RESONANCES. Mitra, A. N. (Univ. of Delhi). Phys. Rev., 151: 1168-71 (Nov. 25, 1966).

A nonrelativistic three-quark (Q) model of baryons and their resonances is proposed with the assumptions of (i) parastatistics, which, in contrast to Fermi statistics, allows totally symmetric wave functions, and (ii) operation of Q-Q forces of the factorable type in s and p waves, which facilitate an exact solution of the three-body problem. It is found that the s-wave force gives rise to a strong attraction in a spatially symmetric (S) state of L = 0, but repulsion in a mixed-symmetric (M) state. This provides a natural dynamical realization of the 56 representation of SU(6) for the familiar octet and decuplet of baryons. The same s-wave force also predicts a set of negative-parity resonances but these are of much too high energy to be of any physical consequence. The p-wave force leads to a set of negative-parity L = 1 resonances via strong attraction in M-type spatial states of L = 1, thus making up the representation (70,3) of SU(6) × O(3). A p-wave spin-orbit Q-Q force splits these states in a manner which fits in rather well with Dalitz's recent analysis of experimental data for the negative-parity baryonic resonances. Finally, the p-wave force generates a strong attraction in a spatially antisymmetric state (A) of even parity and L = 1, giving rise to the representation (20,3) of SU(6) × O(3), of which the lowest states are an octet and a singlet of $J^P = \frac{1}{2}^+$, the central mass of each lying lower than the corresponding lowest mass multiplet of negative parity. This provides a natural explanation of the so-called "Roper" resonance (at 1450 MeV), and in addition, strongly predicts an even-parity singlet of a mass lower than the $Y_0^*(1405)$. The distinction between Fermi statistics and parastatistics is discussed in the context of the above results, and it is argued that while Fermi statistics could in principle generate negative-parity L = 1 resonances (via M functions), it could not possibly account for the 56 of baryons, since with Q-Q forces alone, the A function of L = 0 that should go with it has a strongly repulsive kernel. (auth)

5399 REMARKS ON THE BARYON MASS SPECTRUM. Gyuk, Imre P. (Syracuse Univ., N. Y.); Tuan, S. F. Phys. Rev., 151: 1253-8(Nov. 25, 1966).

Earlier attempts to classify negative-parity baryon states in the intermediate energy range 1 to 2.2 BeV are reviewed, modified slightly, and generalized. The mass spectrum is analyzed in terms of (i) the basic 70^- and 20^- multiplets of SU(6) and (ii) the 70 (L = 1) of SU(6) × O(3). Connection between these possibilities and a fundamental structure composed of quarks and pseudoquarks for case (i) and quarks with "orbital" excitation L = 1 for case (ii), underlying these mass regularities, are briefly discussed. (auth)

5400 πN PHASE SHIFTS AND EIGENSCATTERING. Goldberg, Hyman (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 151: 1186-9(Nov. 25, 1966).

Small variations in eigenphase and mixing-angle behavior are correlated with distinct types of large variations in the elastic phase shift. Applications to recent results for the P_{11} and D_{13} πN phase-shift analyses are discussed. (auth)

5401 COMMUTATION RELATIONS OF BARYON CURRENTS. Hwa, Rudolph C.; Nuyts, Jean (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 151: 1215-25(Nov. 25, 1966).

The notion of baryon "currents" is introduced. The hypothesis [partially conserved baryon currents (PCBC)] is made that the divergences of these baryon currents are related to baryon fields in much the same way that the hypothesis of partially conserved axial-vector current (PCAC) relates the divergences of axial-vector meson currents to pseudoscalar meson fields. On the basis of the quark model, the baryon currents are constructed as linear combinations of the products of three quarks. Using the canonical anticommutation relations for the quarks, the equal-time commutation relations of the baryon currents with vector and axial-vector meson currents are derived. The right-hand sides of these commutation relations turn out to be linear combinations of the baryon currents themselves. As applications the matrix elements of the commutation relations between vacuum and baryon states and between meson and baryon states are considered. The results consist of algebraic relations between various form factors, which can be checked, in principle, by accurate experimental data when available. (auth)

5402 SELECTED TOPICS IN PION-NUCLEON SCATTERING AND PHOTOPRODUCTION. Hoehler, G. (Technische Hochschule, Karlsruhe, Ger.). Nuovo Cimento (1), 3: Suppl., 651-66(1965).

Recent theoretical and experimental results in charge-exchange forward scattering, other πN forward amplitudes, pion photoproduction below 500 MeV, and pion photoproduction above 500 MeV are critically analyzed. (J.S.R.)

Strong (Baryon No. ≥ 2)

5403 Σ HYPERNUCLEI AND Σ^+-PROTON SCATTERING. Tang, Y. C. (Univ. of Minnesota, Minneapolis); Herndon, R. C. Phys. Rev., 151: 1116-22(Nov. 25, 1966).

By analyzing the Σ^+-proton scattering data at low energies, it is found that the triplet Σ-nucleon interaction in the $I = 3/2$ state is certainly not strong enough to support the formation of a particle-stable Σ^-n or Σ^+p system. The singlet Σ-nucleon interaction, on the other hand, could be quite strong, but it is probably still not sufficient to create a bound two-body Σ hypernucleus. Also, because of the relative weakness of the triplet interaction, it can be concluded that a bound hypernucleus Σ^-nn very likely does not exist. Using the results obtained in this investigation, speculations are also made concerning the double-Σ hypernuclear systems $\Sigma^-\Sigma^-n$ and $\Sigma^-\Sigma^-nn$. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 5579.

5404 (NYO-3399-37) $\tilde{U}(12)$ AND CROSSING SYMMETRY. Musto, R.; O'Raifeartaigh, L.; Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). Aug. 9, 1965. Contract AT(30-1)-3399. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In view of a paper which throws some doubt on the compatibility of crossing symmetry and $\tilde{U}$ invariance, the question of their compatibility is examined in detail. It is found that crossing symmetry and $\tilde{U}$ invariance are not incompatible. On account of some disagreement in the literature regarding the definition of crossing symmetry, its definition, and its relation to the substitution law are also discussed in detail. (auth)

5405 RELATIVISTIC ELEMENTARY PARTICLE STATES OF AN INTERNALLY STRUCTURED MODEL. Takabayasi, Takehiko (Nagoya Univ., Japan). Progr. Theoret. Phys. (Kyoto), 36: 662-4(Sept. 1966).

Unitary irreducible representations of the Poincaré group realized by a previous model, which gives a relativistic theory of a structure having internal polarization, are presented in order to represent each elementary particle state in some lower levels. This shows how the relativistic treatment of an arbitrarily moving particle with an internal configuration can be consistently performed on a quantum mechanical basis and also in what manner each solution is equivalent to that obtained from the usual abstract representation theory of the Poincaré group. In principle the method is quite general. It is also shown that the kinematical structure allows zero-mass states to be represented conveniently. (J.F.P.)

5406 MULTIPLICITIES IN WEIGHT DIAGRAMS. McConnell, James (St. Patrick's Coll., Maynooth, Ireland). Proc. Roy. Irish Acad., Sect. A, 65: No. 1, 1-12(May 1966).

The properties of weight diagrams of the B_2 Lie group are studied in detail, and rules for finding multiplicities are derived. It is shown how they are related to Wigner's rule for multiplicities in SU(3) weight diagrams. (auth)

5407 UNITARITY, CAUSALITY, AND FERMI STATISTICS. Feldman, G.; Matthews, P. T. (Imperial Coll. of Science and Tech., London). Phys. Rev., 151: 1176-80(Nov. 25, 1966).

Conventionally, Poincaré-invariant S-matrix elements are constructed from auxiliary field operators, which transform like representations of an auxiliary group. Invariance with respect to the index transformations of this group may be extended to couple spin to internal symmetry properties in a covariant manner, as in $\tilde{U}(12)$ and SL(6,C) theories. It is shown that such an index invariance of the S matrix is compatible with unitarity only if the auxiliary operators are unitary representations of the auxiliary group. It is shown further that local fields transforming as such unitary representations can be made causal only if they satisfy commutation (not anticommutation) relations. Thus for index-invariant theories, a direct incompatibility is established between unitarity and causality for Fermi particles. (auth)

5408 SOME CONSEQUENCES OF AN INTRINSIC MASS FORMULA. Bernstein, Herbert J.; Halpern, Francis R. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-Gen-10. Phys. Rev., 151: 1226-8(Nov. 25, 1966). (UCSD-10P10-4).

The requirements that are placed on a relativistically invariant theory by the assumption that single-particle states with different masses are included in the same multiplet are examined. This assumption implies first that the Lie algebra of the symmetry group which includes the generators of both the Lorentz and internal transformations must also have an infinite number of other elements, and secondly, that the direct product of any two single-particle multiplets is irreducible. (auth)

Applications (Electromagnetic and Weak)

5409 ON ISOTOPIC INVARIANCE OF CP-NONINVARIANT ELECTROMAGNETIC VERTICES. Okun, L. B. Phys. Lett., 23: 595-6(Dec. 5, 1966).

The isotopic selection rules are discussed in the framework of a scheme of strong CP violation proposed by Lee. (According to this scheme the charge conjugation operators C_π and C_γ leaving invariant strong and electromagnetic interactions, respectively, do not coincide with each other.) It is shown that in this scheme CP-noninvariant vertices describing the emission of photons by ordinary hadrons must be necessarily isotopically invariant ($\Delta I = 0$) independent of whether the principle of minimal electromagnetic interaction is applicable to so called a-particles and whether these particles are isotopic singlets. (auth)

Application (Strong)

5410 (AEC-tr-6807) TESTS OF THE CONSEQUENCES OF UNITARY SYMMETRY IN HADRON PRODUCTION REACTIONS. Dolgov, A. D.; Solov'ev, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translation of report No. 333. 90p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In the discussion of the consequences of unitary symmetry in hadron production, dynamic effects of interactions which split the mass of the supermultiplets on the amplitudes of the interactions are not considered, and symmetry violation is included only in relations connecting the square of the matrix element with the cross section. Certain statements of unitary symmetry and ways in which one can establish the unitary invariant principles are briefly described. Meson–baryon interactions with the respective production of the octet of baryons and decuplet of baryon resonances, proton–antiproton pair annihilation, SU(3) predictions for baryon–baryon scattering in S states, meson (f^0) production assuming that this is a singlet relative to SU(3), and hadron photoproduction are discussed. (J.F.P.)

5411 PERMUTATION SYMMETRY OF THE QUARK FIELDS. Watanabe, Ichie (Tokyo Medical and Dental Univ.). Progr. Theoret. Phys. (Kyoto), 36: 668-70(Sept. 1966).

It is shown that the free and interaction hamiltonians may be classified by the permutation symmetry of the appropriate basic fields. (J.F.P.)

5412 SELF-CONSISTENT DETERMINATION OF COUPLING SHIFTS IN BROKEN SU(3). II. Dashen, R. F.; Dothan, Y.; Frautschi, S. C.; Sharp, D. H. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 151: 1127-58 (Nov. 25, 1966). (CALT-68-78).

In a recent paper, the possibility of dynamical enhancement of SU(3) symmetry breaking in baryon couplings was considered. It was found that certain patterns of symmetry breaking are enhanced and tend to dominate; the results were presented and compared with experiment. The methods by which these conclusions were obtained are explained in detail, and a more complete summary of the numerical results is given. (auth)

5413 STRONG VERTEX ACCORDING TO SL(6,C). Fronsdal, C.; White, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., 151: 1287-92(Nov. 25, 1966).

The baryon-meson vertex is calculated to lowest nonvanishing order in momentum transfer, in a relativistic SU(6) theory in which the particles are assigned to unitary (infinite-dimensional) representations of SL(6,C). The coupling 56, 56, 35 contains no arbitrary parameters except for the overall universal coupling strength. All the results are in excellent agreement with experiment. (auth)

5414 SUM RULES FOR COUPLING CONSTANTS IN EXACT AND BROKEN $SU(6)_W$. Gupta, Sachichida Nanda (National Physical Lab., New Delhi). Phys. Rev., 151: 1235-8(Nov. 25, 1966).

The meson-baryon vertex and the decuplet decays are studied within the framework of the exact and the broken $SU(6)_W$ group. The breaking is provided by a W-spin scalar spurion transforming like the $I = 0$, $Y = 0$ member of the 35-dimensional adjoint representation of $SU(6)_W$. Twenty-one sum rules are obtained in the broken symmetry. One of these directly relates the $(p,p\pi^0)$ and $(N^{*++},p\pi^+)$ couplings and yields a decay width $\Gamma(N^{*++} \to p\pi^+) = 70$ MeV. Another relates the vertices $(Y_1^{*+},\Lambda\pi^+)$ and $(Y_1^{*+},\Sigma^+\pi^0)$, which seems to agree with the latest experiments on Y_1^* decays. One more relation among the observable decuplet decays is the Gupta-Singh sum rule, which is very well satisfied experimentally. Some predictions of exact $SU(6)_W$ seem to disagree with experiment. It is concluded that in the context of three-point functions the predictions of the broken $SU(6)_W$ group are in very good agreement with experiments. (auth)

5415 PHYSICAL REDUCTIONS IN HIGHER SYMMETRIES. Rolnick, William B. (Case Inst. of Tech., Cleveland). Phys. Rev., 151: 1171-5(Nov. 25, 1966).

It is shown that only reductions with respect to particular subgroups occur in a certain class of physical theories of higher symmetry. It is proven that each irreducible representation (except the trivial one) of a simple Lie group of rank three contains representations of different triality of any SU_3 subgroup thus embedded. (auth)

Quantum Field Theories

5416 (NYO-1932-115) INTERACTIONS OF MASSLESS SPINORS IN TWO DIMENSIONS. Dubin, Daniel A. (New York Univ., N. Y. Dept. of Physics); Tarski, Jan (Columbia Univ., New York. Dept. of Physics). [1966]. Contract AT(30-1)-1932. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The interaction of massless spinors with massive vector mesons ($m_0 > 0$) in two dimensions is investigated (the vector meson model). Two definitions of the current are considered, and operator solutions employing auxiliary free fields are constructed. However, the presentation is heuristic in part, and the problem of positive definiteness of the theory is left open. The limit $m_0 \to \infty$ is easily obtained; it yields the Thirring model. Some complications are indicated in connection with the limit $m_0 \to 0$, to the Schwinger model. (auth)

5417 PECULIARITY IN THE PERTURBATION THEORY. Troitskii, V. E.; Shirokov, Yu. M. Zh. Eksp. Teor. Fiz., 51: 1413-16(Nov. 1966). (In Russian).

It is shown in the frames of the perturbation theory that the Heisenberg two-particle matrix element $\langle pk|A(x)|p'k'\rangle$ of a neutral scalar field has a singularity when $K \to \infty$, where $K = p + k - p' - k'$. (auth)

5418 QUASI-ANALYTICAL FUNCTIONALS IN QUANTUM FIELD THEORY. Gachok, V. P. (Inst. of Mathematics, Academy of Sciences, Ukrainian SSR). Dokl. Akad. Nauk SSSR, 168: 1030-2(June 11, 1966). (In Russian).

The problem of moments in quantum field theory was analyzed. The problem is related to the self-conjugated properties of field operators. The study showed that in the case of quasi-analytical functionals the field operators are subjected to self-conjugated closure. Moreover, it is shown that the equation $E_\lambda(f)E_\mu(g) = E_\gamma(f \times g)$ is present in the spectral series $E_\lambda(f)$, $E_\lambda(g)$, $E_\gamma(f \times g)$ for the operators $A(f)$, $A(g)$, $A(f \times g)$ respectively. The basis for Neumann ring closure in field theory is thus found. The results may be used to study self-conjugated expansions, other field theory operators, and in statistical physics. (G.O.Y.)

5419 NECESSARY DEPENDENCE OF CURRENTS ON FIELDS THEY GENERATE. Boulware, D. G. (Univ. of Washington, Seattle); Deser, S. Phys. Rev., 151: 1278-86(Nov. 25, 1966).

It is shown that in local (proper) Lorentz-invariant theories involving axial-vector, or tensor currents (conserved or not), the latter must vanish, if they commute at equal times with the fields they generate. The need for explicit field dependence of currents is demonstrated for gradient-coupled spinless and massive spin-one fields, as well as for electrodynamics with minimal or nonminimal coupling. The field-dependence requirement is distinct from that (already needed for free fields) of "spreading points" to make the current operators well-defined. The relation between the two, however, essentially fixes the form of this dependence. Applications are made to partially conserved currents, $\partial_\mu j^\mu = \alpha\varphi$; if j^0 commutes with φ, the latter vanishes. (auth)

5420 GAUGE INVARIANCE AND CURRENT DEFINITION IN QUANTUM ELECTRODYNAMICS. Boulware, David G. (Univ. of Washington, Seattle). Phys. Rev., 151: 1024-37 (Nov. 25, 1966).

In order to study the problems of gauge invariance, Lorentz covariance, and the operator properties of the "Schwinger terms" in the current commutators, spin-½ quantum electrodynamics is written as the limit of a nonlocal theory. The conditions on such a theory are discussed and the nonlocal equations in the case of an external vector potential derived. The gauge-invariant, Lorentz-covariant limit of these equations is then discussed, and it is found that (in the case of spin ½) the "Schwinger terms" are purely c-number. The quantized vector potential is considered by means of a Feynman path integral and its gauge structure determined. It is found that an automatically gauge-covariant theory results and that the c-number character of the Schwinger terms apparently persists. (auth)

5421 ELECTRIC- AND MAGNETIC-CHARGE RENORMALIZATION. II. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Contract AF 49(638)-1380. Phys. Rev., 151: 1055-7(Nov. 25, 1966).

Further evidence for the universality of charge renormalization is derived by examining the photon radiation and the static interaction of prescribed transverse currents. (auth)

5422 ELECTRIC- AND MAGNETIC-CHARGE RENORMALIZATION. I. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Contract AF 49(638)-1380. Phys. Rev., 151: 1048-54(Nov. 25, 1966).

An important question in the field theory of electric and magnetic charge is the relative renormalization of the two kinds of charges. A general view of renormalization, as a scale change introduced in proceeding from the field to the particle level of description, indicates the universality of charge renormalization. This is confirmed by an explicit calculation of the long-range interaction of static charges. (auth)

Scattering Theory

5423 EXTREMAL VALUE OF THE DIFFERENTIAL ELASTIC SCATTERING CROSS SECTION. Arushanov, G. G. Zh. Eksp. Teor. Fiz., 51: 1402-4(Nov. 1966). (In Russian).

A conditional extremum of the differential elastic scattering cross section is found for definite total cross sections. The ratio of the extremal value of the cross section of the backward scattering to its value at 90° increases with the energy rise as a square root of energy in the laboratory system of coordinates (at constant total cross sections). (auth)

5424 ARE THE RESIDUES OF INTERACTION POLES IN THE N/D METHOD A RIGHT MEASURE OF THE FORCES? Daboul, J. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 23: 592-4(Dec. 5, 1966).

It is shown that the residue g_i of the interaction poles are not the right measure for the effect of the forces. A simple example is constructed to clarify this point. The products g_iD_i should be used instead, where D_i are the values of the D function at the positions of the poles. (auth)

5425 FORWARD AND BACKWARD PEAKS AT HIGH ENERGIES. Jin, Y. S. (Brown Univ., Providence). Phys. Rev., 151: 1259-61(Nov. 25, 1966). (NYO-2262TA-127).

Using a high-energy bound such as the Froissart bound or the Kinoshita-Loeffel-Martin bound, the relation between the high-energy growth of the forward (backward) transition amplitude and the existence of the forward (backward) peak in any two-particle reaction A + B → C + D is obtained. Possible improvement of the result is briefly discussed. (auth)

5426 OPERATOR FOR TIME DELAY INDUCED BY SCATTERING. Lippmann, B. A. (DRC Inc., Santa Barbara, Calif.). Phys. Rev., 151: 1023-4(Nov. 25, 1966).

The operator that gives the time delay induced by a scattering process is exhibited explicitly. (auth)

5427 FORMAL THEORY OF n-PARTICLE SCATTERING. II. Weyers, J. (Univ. of Louvain, Belg. Case Inst. of Tech., Cleveland). Contract AT(11-1)-1573. Phys. Rev., 151: 1159-67(Nov. 25, 1966). (COO-1573-2).

Prescriptions are given for constructing S-matrix elements from the general theory of n-particle scattering previously developed. Some simple models based on the separable approximation are discussed and a method for including corrections to this approximation is described. (auth)

Particle Accelerators

5428 (BNL-10813) GENERAL CONDITIONS FOR ACHIEVING PHASE SHIFTS OF π AND 2π BY MEANS OF QUADRUPOLE MULTIPLETS. Regenstreif, E. (Brookhaven National Lab., Upton, N. Y.). Oct. 24, 1966. Contract AT(30-2)-Gen-16. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The general theory is given for formulating analytic conditions for achieving phase shifts of π and 2π by means of magnetic multiplets (mainly quadruplets, quintuplets, and sextuplets) composed of quadrupoles. The thick lens approach is used throughout, and no use is made of the thin lens approximation. (J.F.P.)

5429 (CERN-66-31) PULSED D.C. POWER SUPPLY 16kA, 60 V SCHNEIDER-WESTINGHOUSE. Isch, H. W. (European Organization for Nuclear Research, Geneva (Switzerland)). Oct. 20, 1966. 29p. Dep. mn.

The power supply for the septum magnets employed for the slow and fast ejection from the CERN Proton Synchrotron straight-sections 58 and 62 is described. The power supply feeds the ejection magnets with dc current pulses of high stability and small ripple. The results of the tests made on the power supply are given. (B.G.D.)

5430 (DESY-66/28) VERMESSUNGSGRUNDLAGEN UND JUSTIERUNG VON EXPERIMENTEN. (Survey Principles and Adjustment of Experiments). Loeffler, Franz (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Oct. 1966. 40p. (In German). Dep. mn.

The basic parameters for the surveying of the synchrotron and experimental setups are given. The equipment of the surveying team and the methods applied in adjusting the experimental magnets are described. (auth)

5431 (LA-DC-8255) DESIGNING RESONANT CAVITIES WITH THE LALA COMPUTER PROGRAM. Hoyt, H. C. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 17p. (CONF-661021-27). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

Cavity design studies using the LALA computer program are reported. The three studies included are concerned with $\beta = 0.65$ proton linac cavities, $\beta = 1$ electron linac cavities, and the cavity in the coaxitron microwave amplifier tube. (B.G.D.)

5432 (MURA-723) RF PERTURBATION MEASUREMENTS IN LONG LINAC CAVITIES. Owen, C. W.; Radmer, C. A.; Young, D. E. (Midwestern Universities Research Association, Stoughton, Wis.). Oct. 3, 1966. Contract W-31-109-eng-38. 22p. (CONF-661021-24). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Linear Accelerator Conference, Los Alamos, N. Mex.

Equipment and procedures are described for measuring the axial accelerating electric field in long linear accelerator standing wave cavities. The method used is the usual one of measuring the change in resonant frequency caused by a small perturbing sphere on the axis of the cavity. This is done by specially developed equipment connected to an on-line digital computer. Readings are taken at millimeter intervals along the axis allowing the fields to be accurately plotted, integrated, and compared. The method is more rapid and accurate than has previously been possible, and analyses can be carried out readily on the data. The equipment has been used on the 50 MeV linac injector for the Zero Gradient Synchrotron at Argonne National Laboratory. The increased knowledge of the axial accelerating electric field obtained with this equipment should allow improved performance of the linac. (auth)

5433 (NYO-3364-21) INDUCED RADIOACTIVITY IN THE COLLIMATOR SYSTEM OF A 31 MeV BROWN BOVERI BETATRON. Stroemme, Aksel (Norsk Radiumhospital, Oslo). [nd]. Contract AT(30-1)-3364. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

It is found that during use some radioactivity is induced in the collimator system of the BBC 31-MeV betatron. Direct handling of the equalizer system is to be avoided because otherwise the doses to the hands can exceed 150–200 mR a day. But if the hands are placed not closer than about 15 cm from the equalizer system, the dose to the hands will not exceed 3–4 mR even on a busy day. If care is taken the radiation hazards due to induced radioactivity after collimator irradiation are of no practical importance. In modern betatrons the collimator system with the field equalizer is safely mounted inside the apparatus and remotely controlled, and there is thus no radiation hazard from the collimator system. (auth)

5434 (SLAC-PUB-217) THE DESIGN OF THE STANFORD 3-GeV ELECTRON-POSITRON STORAGE RING. Rees, John R. (Stanford Linear Accelerator Center, Calif.). Sept. 1966. Contract AT(04-3)-400. 18p. (CONF-660939-1). DTIE.

From International Symposium on Electron and Positron Storage Rings, Saclay, France.

The Stanford 3-GeV storage ring design was revised to incorporate long straight sections having very small values of the vertical β-function at their centers. The beam reaches a minimum in vertical dimension in the center of a 5-meter-long free space for high-energy detectors. The displacement of the equilibrium orbit for off-momentum particles is zero throughout the experimental regions and is unaffected by adjustments of the interaction-region quadrupoles. The rf power provided is 1.3 megawatts. The luminosity ranges from 1.3×10^{32} cm^{-2} sec^{-1} at 3 GeV up to 2.5×10^{33} at 1.3 GeV. The considerations leading to the design will be discussed. (auth)

5435 (TID-23395) PROGRESS REPORT [ON NUCLEAR PHYSICS], AUGUST 1965–JULY 1966. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Contract AT(11-1)-1265. 215p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The performance of the proton linear accelerator is discussed, and brief accounts are given of the experiments performed using the machine. Improvements to both the machine and the experimental instrumentation are outlined. Performance tests on a new 500-keV injector are reported. Work on the tandem Van de Graaff accelerator was concerned with the assembly and installation of the machine and with preparations for experimental work. Work is also reported on elastic and inelastic proton scattering; pickup reactions; isomeric states in nuclei; measurements of the linear accelerator spectrometer; optical model studies; the diffraction model for direct reactions; investigation of analog laws for E-dE/dx systems; properties of bound states of one-particle one-hole nuclei near ^{208}Pb; quasi-elastic scattering; on-line computer operation; particle detection systems electronic instrumentation; and mechanical instrumentation. (S.F.L.)

5436 (UCID-2851) CONCERNING THE SELF FIELDS OF A BEAM OSCILLATING TRANSVERSELY IN THE PRESENCE OF CLEARING-ELECTRODE PLATES. Laslett, L. Jackson (California Univ., Berkeley). Aug. 11, 1966. Contract W-7405-eng-48. 13p. DTIE.

The development of electromagnetic fields generated by an unbunched beam oscillating transversely between a sequence of identical pairs of clearing-electrode plates that cover substantially the full width of a vacuum chamber with resistive walls is reported. The electric termination of each electrode is at the center of its length. The wavelength of the beam oscillation is taken to be large in comparison to the transverse dimensions of the chamber, and expressions are derived for the fundamental component of the fields that produce a transverse force on the oscillating beam. As a simplifying approximation, the charge and current distributions on the transmission-line structure formed by the electrodes are assumed independent of the transverse coordinate. (B.G.D.)

5437 (UCID-15046) PROPOSED HIGH INJECTION RATE, VACUUM-TUBE-MODULATED, 1000A ELECTRON ACCELERATOR. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 15, 1966. Contract W-7405-eng-48. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A general outline and cost estimate of a proposed electron accelerator for the Astron facility are presented. The parameters of the proposed new accelerator are: electron energy, 4 MeV; beam current, 1000 A; pulse length, 0.3 μsec; and repetition rates, 500 kc in burst mode and 2500 pps in CW operation. (B.G.D.)

5438 (UCRL-17133) EXPERIMENTAL PROBLEMS IN THE USE OF A POLARIZED PROTON TARGET. Chamberlain, Owen (California Univ., Berkeley. Lawrence Radiation Lab.).

Sept. 9, 1966. Contract W-7405-eng-48. 18p. (CONF-660918-3). DTIE.

From International Conference on Instrumentation for High Energy Physics, Stanford, Calif.

Experimental problems in the use of polarized proton targets, particularly lanthanum magnesium nitrate (LMN), are discussed. The difficulties are: hydrogen events must be separated from heavy-nucleus events, existing targets tend to be rather thick when measured in radiation lengths, the LMN is easily damaged by radiation, proton polarization need not be the same in all parts of the sample, the absolute degree of target polarization is uncertain by about 10%, targets require a delay each time polarization direction is reversed, and extra personnel are required to operate the target. (B.G.D.)

5439 ADONE: PRESENT STATE OF WORK. Adone, Gruppo (CNEN, Frascati, Italy). Nuovo Cimento (1), 3: Suppl., 501-5 (1965). (In Italian).

The construction program for ADONE for the 450 MeV electron and positron linear accelerator is briefly outlined. The available experimental and theoretical data indicate that the preliminary designs were adequate and construction can proceed with security. (J.S.R.)

5440 CHARGED PARTICLE MOTION IN A HELICAL MAGNETIC FIELD. Khapaev, M. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 2, 123-7(1966). (In Russian).

Linear motion of charged particles in a helical magnetic field was studied using an averaging formulation for the motion equation. The averaging formulation was constructed, and adiabatic invariances were found and applied in the computation of basic parameters for the focusing system. (R.V.J.)

5441 CHARGE DISTRIBUTION OF ^{16}O IONS PRODUCED FROM TANDEM ACCELERATOR. Preikschat, E.; Cramer, J. G. (Univ. of Washington, Seattle). Rev. Sci. Instrum., 37: 1722-6(Dec. 1966). (RLO-1388-7).

In an effort to obtain information about the acceleration of heavy ions in tandem accelerators, the charge state distribution of oxygen ions accelerated in the University of Washington FN tandem accelerator was measured at three terminal voltages and over a range of stripper pressures. It is found that the stripper pressure normally used is below the value required for equilibrium in the charge exchange process, but that at higher terminal voltages the average charge state of the ions can rise above the equilibrium value due to focusing effects in the accelerating tubes. This phenomenon has implications in the use of foil strippers with heavy ion beams. A useful empirical relation for the optimum stripper pressure for a given charge state is obtained. (auth)

5442 NONBOILING LIQUID HYDROGEN TARGET. Jarmie, Nelson (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instrum., 37: 1670-1(Dec. 1966). (LA-DC-8106).

A thin 2 mm liquid hydrogen target is described. It operates at conditions away from the boiling curve and can therefore absorb considerable (200 mW) power from an accelerator beam without serious boiling. Construction and operation are discussed and several additional advantages are presented. (auth)

5443 PARTICLE STORAGE RINGS. O'Neill, Gerard K. Sci. Amer., 215: No. 5, 107-16(Nov. 1966).

The colliding-beam principle for studying particle interactions is discussed, and a survey is given of the theoretical and practical development of particle storage rings for high-energy experiments. Brief descriptions are given of the basic design and development of the storage rings at Stanford, Frascati, and CERN. (L.B.S.)

5444 THE 60-MeV GRENOBLE ISOCHRONOUS CYCLOTRON. Sen, N. C. (Centre de Physique Electronique et Corpusculaire, Orsay, France). Indian J. Phys., 40: 294-302 (June 1966).

The 60-MeV variable-energy isochronous cyclotron designed and constructed for the University of Grenoble is described. A general description of the machine along with methods of calculations, operational characteristics, and special features are given. (auth)

5445 MESON FACTORIES. Rosen, Louis. Phys. Today, 19: No. 12, 21-5; 28-31; 33-6(Dec. 1966). (LA-DC-7684).

The design and development of accelerators, called meson factories, which will produce 500- to 1000-MeV nucleons and mesons in beams thousands of times more intense than those from existing machines are considered. Topics discussed include the purposes for the accelerator development and its uses such as the investigation of internucleon forces using nucleon and meson probes, applications to chemistry and particle physics, and also practical applications. Various meson factory designs are described and compared. (J.F.P.)

5446 METHOD FOR STABILIZING THE ELECTRON-ACCELERATING VOLTAGE. Nagaya, Takashi (to Hitachi Ltd.). Japanese Patent 1965-26650. Nov. 19, 1965. Filed Sept. 5, 1962.

In the high voltage stabilizer proposed, the electromagnetic waves, emitted from the electron rays accelerated by means of a high voltage, are detected, and the electrical signal of detection of the electromagnetic waves is fed back to the control for the accelerating high-voltage, thereby giving a high stabilization of the voltage. Claim: It consists of the following: a device for emitting electromagnetic waves from the high-voltage accelerated electron rays; a device for detecting the variation in the wave-length of the electromagnetic waves, corresponding to the variation in the accelerating high-voltage; a device for converting the wave-length variation into an electrical signal; and a device for controlling the accelerating voltage by means of the electrical signal. (NSA of Japan)

5447 PULSED CHARGED-PARTICLE BEAM ACCELERATING DEVICE. Takeda, Koji (to Hitachi Ltd.). Japanese Patent 1965-26518. Nov. 17, 1965. Filed Sept. 30, 1963.

An improved pulsed charged-particle beam accelerator (such as a linear accelerator) is proposed. The improvements achieved in this accelerator are as follows: simplified structure of the coils used in focusing or deflecting a charged-particle beam; reduction in the electric power consumed by the coils; decrease in the heat produced in the coils; elimination of the cooling device for the coils; exclusion of a power source usually used solely for the coils (a power source for other purposes is used in common by the coils); and easy attaching or detaching of the coils to or from the accelerating tube, achieved by the divided construction around the circumference. The accelerator consists of a charged particle source; a device for accelerating the pulsed charged particles; and the coils, installed along the path of accelerated charged particles, which act on the particles. The coils are excited by the pulsed current synchronized with the pulsed charged-particle beam; by the pulsed current, flowing through part of the circuits of a pulsed-power source for injecting the charged particles (from the source) in pulses; and by the pulsed current, flowing through part of the circuits of a power source for activating the high-frequency tube (for accelerating a charged-particle beam). In construction of the coils, the coil is divided in an appropriate number around the circumference. (NSA of Japan)

5448 CHARGED-PARTICLE BEAM ACCELERATING DEVICE. Takeda, Koji (to Hitachi Ltd.). Japanese Patent 1965-25999. Nov. 11, 1965. Filed Oct. 22, 1964.

A charged-particle beam accelerating device, employing high-frequency waves as the means of acceleration, which is small in size and simple in construction is proposed; in this accelerating device, the net accelerating efficiency is also increased beyond those attainable in the conventional similar devices. By embodying the high-frequency wave generator, high-frequency wave transmitting circuits, and high-frequency wave particle accelerating part, which are usually separately installed, the drawback in the size of a beam accelerating device becomes large due to the use of microwave circuits can be eliminated. In the charged-particle beam accelerating device are provided the following: at least two charged-particle beam ejectors; a device which makes at least two groups of charged particles (from the ejectors) pass through the respective passages in the high-frequency wave field. The passage of one group (at least) to be accelerated is located in the relatively low electric field of the said high-frequency field, while that of the other group (at least one group) to be decelerated is in the relatively strong electric field. The former group supplies energy into the high-frequency wave field, and the latter group acquires energy from the same field. (NSA of Japan)

5449 CHARGED-PARTICLE ACCELERATOR. Maekawa, Akitsugu (to Hitachi Ltd.). Japanese Patent 1965-22840. Oct. 8, 1965. Filed Oct. 25, 1963.

A charged-particle accelerator, which is of less cost and more compact than the conventional accelerators, is proposed. This is achieved by eliminating the output radiowave coupler and radiowave absorbing member (usually installed at the end of an accelerating tube), and the reflected-wave removing device by having the acceleration and wave absorption near the end of the accelerating tube. It consists of a charged-particle source, a high-frequency radio-wave source, and an accelerating tube for acceleration of the injected charged-particles. At least a part near the end of the accelerating tube is made from a highly insulating material having a large gas adsorption such as titanium. (NSA of Japan)

5450 METHOD FOR CONSTRUCTION OF AN ACCELERATING TUBE. Hatano, Juichi (to Tokyo Shibaura Electric Co. Ltd.). Japanese Patent 1965-22520. Oct. 5, 1965. Filed Dec. 11, 1962.

A method is proposed in which the metal discs and cylindrical bodies, arranged one after the other, are heated at a high temperature to connect them together for giving an accelerating tube; in this case, unlike in the conventional method, no plating is employed. The accelerating tube, which is thus obtained easily, is smooth on the inner surface and has little contamination, leading to a reduced loss of the microwaves. The metal discs and cylindrical bodies (forming cavity resonators of an accelerating tube with filter circuits) are arranged alternately in series. These discs and cylinders are heated, while pressed against one another, in a vacuum or in an atmosphere of a reducing or neutral gas. Then the metal in both the discs and cylinders diffuse into each other, resulting in the joining of the discs and cylinders. (NSA of Japan)

5451 PARTICLE ACCELERATOR. **Matsushita, Masaharu (to Matsushita Electric Industries Co., Ltd.). Japanese Patent 1965-20958. Sept. 17, 1965.** Filed Dec. 18, 1964.

A particle accelerator is proposed in which the accelerating tube, its extension, and a target are all contained in a tank, and the spaces between the tank wall and these components are filled with an insulating oil, thereby providing the insulation among the respective accelerating electrodes. The charged particles are accelerated by applying a high voltage to one end of the accelerating tube. In the conventional accelerators of this type, the particle source side (electrons or other ions) is kept at a high potential, the particle source and the accelerating tube are exposed to the atmosphere, and the accelerating-tube extension and a target are earthed to ground. In this type, however, the electrical power required to produce the charged particles or ions must be provided by the use of an insulated transformer or the dynamo installed at the source side must be operated. In addition, the manipulation necessary for adjustment of the particle source must all be done remotely, and because of the exposure to the atmosphere of both the accelerating tube and the particle source, the operation is very dangerous. (NSA of Japan)

5452 BETATRON. **Kanamori, Koji** (to Shimadzu Seisakusho Ltd.). **Japanese Patent 1965-27280. Nov. 30, 1965.** Filed Mar. 9, 1964.

An improved electron injector whereby the output of the betatron can be increased is proposed. In this electron injector, not all the accelerated electrons are injected into the circular (betatron) accelerating tube, but they are introduced into it intermittently at the suitable intervals. The total amount of injected electrons is small, compared with the conventional injectors, but on the contrary, the output of the betatron can be increased due to the reduced effect of space charge. In this method, the deflecting plate is impressed at some intervals in the form of pulses. The voltage applied to the plate is very low, 4000 to 10,000 v, in comparison with the high voltage, 40,000 to 100,000 v, of the accelerating voltage, and so the pulse control is easy. The betatron employs the following: an accelerating tube (this is not the betatron tube) with the deflecting plate for injecting electrons into the betatron circular path; a voltage source for supplying accelerating voltage to the electron gun; and a pulsed-voltage source for supplying pulsed voltage to the deflecting plate. Thus, as described above, electrons from the electron gun are injected into the circular accelerating tube intermittently. (NSA of Japan)

5453 PARTICLE ACCELERATOR. **Machiyama, Yoshihiko (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1966-799. Jan. 26, 1966.** Filed May 2, 1964.

In the particle accelerator proposed, the drawbacks which the conventional similar accelerator with electron irradiation and x-ray (or neutron) generation in the same system has, are removed. That is, this accelerator can provide an electron and an x-ray beam without deflecting it and furthermore without taking it into the atmosphere. It consists of the following: the charged-particle accelerating device; the support body, opposed to the end of the accelerating tube, having the passage of an accelerated-electron beam; a support rod for a target which travels in the direction traversing the passage of an electron beam (adjoining the position of a target, an opening is provided through the support rod for passage of an electron beam); and the bellows installed air-tight covering the space between the support rod and the inner side of the support body. (NSA of Japan)

5454 PARTICLE ACCELERATOR. **Machiyama, Yoshihiko (to Mitsubishi Heavy Industries, Ltd.). Japanese Patent 1966-798. Jan. 26, 1966.** Filed May 2, 1964.

In the particle accelerator proposed, the drawbacks of the conventional similar accelerators in which charged-particle acceleration and x-ray (or neutron) generation are achieved in the same system are removed. That is, this particle accelerator can provide an electron or an x-ray (or neutron) beam without deflecting it and furthermore without taking it into the atmosphere. The particle accelerator is provided with the following: a plurality of targets for producing the respective particles by electron irradiation; the support frame for the targets, equipped with a cooling device; and the mechanism for moving the target support so as to position a given target in the path of an electron beam. (NSA of Japan)

5455 METHOD FOR ADJUSTING THE NONUNIFORM MAGNETIC-FIELD DISTRIBUTION FOR A BETATRON. Hattori, Hiroyuki (to Shimazu Seisakusho Ltd.). **Japanese Patent 1966-797. Jan. 26, 1966.** Filed Apr. 12, 1964.

A method is proposed in which the nonuniform magnetic-field distribution at the time of injection of electrons can be made uniform, thereby increasing the output of the betatron and also simplifying the structure of the magnet. Hollows are cut through the yoke at suitable positions on the line at right angles to the direction of yoke. Into these hollows is inserted an iron core. The uniformity in the magnetic-field distribution at the time of electron injection can be achieved by adjusting the part of iron core which protrudes from the lower side of the yoke, hence the distance from the magnetic pole to the top of the inserted iron core. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 5317 and 5611.

5456 (AEEW-R-491) THE F.D.2 GROUP AVERAGED CROSS SECTION SET FOR FAST REACTOR CALCULATIONS. Smith, R. W.; Rowlands, J. L.; Wardleworth, D. (Atomic Energy Establishment, Winfrith (England)). Aug. 1966. 67p. Dep. BIS $1.80. HMSO 9s.

The F.D.2 is a 33-group cross-section library produced for sodium-cooled fast reactor calculations. The data were derived mainly from the UKAEA Nuclear Data Library using the GALAXY program and a smooth weighting spectrum which approximates that of a large sodium-cooled fast reactor. Other sources were used to provide: resonance shielding factors for ^{235}U, ^{238}U, ^{239}Pu, and ^{240}Pu; sodium elastic moderation and transport cross sections and the capture cross section for the 3-keV resonance; elastic moderation cross sections for oxygen, chromium, iron, and nickel; and data for substances that are not included in the Nuclear Data Library, or for which more recent evaluations are available. With the exception of the highest energy group, the group boundaries are at half-lethargy intervals based on an origin at 10 MeV. The top group covers energies above 3.68 MeV and has a ^{235}U fission-spectrum weighting. The remaining 32 half-lethargy groups cover the energy range down to 0.414 eV. The scatter matrix was limited to ten down-scatter groups with scattering to lower energies included in the scattering to the tenth down-scatter group. (S.F.L.)

5457 (CEA-R-3010) LE COEFFICIENT DE DIFFUSION EN FONCTION DE L'ENERGIE DES THERMALISEURS USUELS. (The Diffusion Coefficient as a Function of Energy for Usual Moderators). Cadilhac, Michel; Livolant, Michel; Pillard, Denise; Soule, Jean-Louis (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 1966. 48p. In French. Dep. mn.

After a review of the definition of the energy function to be taken for the diffusion coefficient used in calculations of reactor cells, in the elementary theory of diffusion, various possible approximations of this function are given. These approximations are shown to be accurate enough for practical uses. Methods for the direct calculations of these approximations for the currently used "normal" models (methods avoiding the calculation of differential cross sections) are described; these methods are applied to several usual moderators at various temperatures (according to different models. (auth)

5458 (GA-7136) CONSTRUCTION OF STATISTICAL RESONANCES IN THE UNRESOLVED RESONANCE REGION: THE PSEUDO CODE. Dyos, M. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). May 26, 1966. Contract AT(04-3)-167. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A description is given of the PSEUDO code for the construction of statistical resonances in the unresolved resonance region. The code will construct resonance parameters, using random sampling techniques, which can be punched out on cards for use as input to a slowing-down code. (auth)

5459 (GA-7287) DIFFERENTIAL NEUTRON THERMALIZATION. Quarterly Technical Report, April 1, 1966–June 30, 1966. Whittemore, W. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 22, 1966. Contract AT(04-3)-167. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Improvements were made in the experimental facility, particularly the chopper used in the neutron velocity selector; and neutron scattering by D_2O and reactor-grade graphite was investigated with emphasis on the analysis of the experimental data. Data were reduced to the scattering law representation, and the experimental results were compared with theoretical predictions. (D.C.W.)

5460 (KAPL-P-3176) EVALUATION OF NEUTRON CROSS SECTIONS: CALCULATIONAL METHODS AND EVALUATED LIBRARIES. Francis, N. C.; Lubitz, C. R; Reynolds, J. T.; Slaggie, E. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). [1966]. Contract W-31-109-eng-52. 17p. (CONF-661014-6). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From IAEA Conference on Nuclear Data, Paris, France.

Two theoretical models are outlined which are useful, in conjunction with experimental data, for providing neutron cross sections for reactor and shielding calculations. Several recommended sets of derived data are also given. (S.F.L.)

5461 (LA-DC-8148) THE NUCLEAR EXPLOSION AS A SINGLE BURST NEUTRON SOURCE. Diven, B. C. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 11p. (CONF-660925-3). DTIE.

From Seminar on Intense Neutron Sources, Santa Fe, N. Mex.

A brief discussion is made of the use of nuclear explosions as pulsed neutron sources for time-of-flight cross-section measurements. Because of the high intensity, good signal-to-background ratios can be obtained. The method is especially adapted to measurements with radioactive samples that produce undesirable background in conventional laboratory experiments. (S.F.L.)

5462 (UCRL-50132) COMPUTER-ORIENTED NEUTRON DATA STORAGE AND RETRIEVAL SYSTEM. Cahill, W. J.; Thompson, D. W.; Perkins, S. T.; Howerton, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 23, 1966. Contract W-7405-eng-48. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A machine-independent, computer-oriented neutron data storage and retrieval system is described. (auth)

5463 (WANL-TNR-189) VARI-QUIR III: A TWO-DIMENSIONAL STEADY STATE MULTI-GROUP DIFFUSION CODE. Collier, G.; Riese, J. W. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 1964. Contract SNP-1. 74p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

A variational approximation is developed for the steady-state neutron diffusion equations. The method is incorporated into a computer code, which allows up to 18 energy groups and 23 different material regions. The code can handle problems with X-Y and R-Z geometries. An R-Θ version of the code is being written; the equations for R-Θ geometry are also given. (auth)

5464 (WAPD-TM-598) MAR-1: A FORTRAN IV PROGRAM FOR CONSTRUCTION FROM MULTIGROUP CROSS SECTIONS OF COMPATIBLE CROSS SECTION DATA IN FINE ENERGY DETAIL AND FOR ADDITION OF THESE DATA TO THE ROC NUCLEAR DATA LIBRARY TAPE. Harris, D. R.; Noll, C. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1966. Contract AT-11-1-GEN-14. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The computer program MAR-1, a FORTRAN IV program for constructing cross-section data in fine energy detail from multigroup cross-section data, is described. The multigroup data are drawn from the MILC library tape, and the computed fine detail data are punched on cards for input to the ROC-1 program which adds the data to the ROC nuclear data library tape. (D.C.W.)

5465 (ORNL-tr-1371) ZEUS 2 PROGRAM: ONE-VELOCITY THREE-DIMENSIONAL MONTE CARLO. Devillers, C.; Lafore, P.; Nimal, J. C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report DEP-SEPP-488--66. 21p. Dep. mn. JCL $2.00 fs, $0.83 mf.

The computer program ZEUS 2 for the solution of the one-group transport equation in a three-dimensional geometry defined by planes and quadrics using the Monte Carlo method is described. (D.C.W.)

5466 (ORNL-tr-1379) GEOMETRIC TREATMENT OF TRAJECTORIES IN THE 05R PROGRAM. Caseau, Yvette (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CENFAR-17. 22p. Dep. mn. JCL $2.60 fs, $0.86 mf.

A geometric analysis based on the 05R program is given for neutron trajectories in a system composed of up to 16 different media. The system studied is enclosed in a rectangular parallelepiped, the sides of which are parallel to the planes of the coordinates. A complete flow sheet is given for the geometric treatment. (S.F.L.)

5467 (ORNL-tr-1380) STUDY OF THE INTERACTIONS OF NEUTRONS WITH MATTER BY THE MONTE CARLO METHOD (AMERICAN PROGRAM 05R). Paillere, P. Translated for Oak Ridge National Lab., Tenn., from the French. 29p. Dep. mn. JCL $2.60 fs, $1.07 mf.

The operation of the 05R neutron transport program and possibilities for its application to neutron interactions with matter are described. The application to anisotropic elastic scattering and inelastic collisions is described. (S.F.L.)

5468 EQUIVALENCE OF SPECIAL MODELS IN ENERGY-DEPENDENT NEUTRON TRANSPORT AND NONGREY RADIATIVE TRANSFER. Stewart, John C. (Univ. of Colorado, Boulder); Kuscer, Ivan; McCormick, Norman J. Ann. Phys. (N. Y.), 40: 321-33(Nov. 1966).

Mathematical equivalence is demonstrated between problems for a separable scattering kernel in energy-dependent neutron transport and for the uniform line-blanketing model of nongrey radiative transfer. As an example, the solution of the Milne problem is rederived by the method of singular eigenfunctions, with the application of orthogonality relations. (auth)

5469 s- AND p-WAVE NEUTRON SPECTROSCOPY. PART III-b. AREA ANALYSIS OF NEUTRON RESONANCES INCLUDING EFFECT OF DOPPLER BROADENING. **Seth, Kamal K. (Northwestern Univ., Evanston, Ill.); Tabony, Robert H. Ann. Phys. (N. Y.), 40: 183-96(Nov. 1966).**

The method of area analysis of neutron resonances observed in transmission experiments was extended to include the effect of Doppler broadening of these resonances. A Breit–Wigner single-level formula including interference between resonance scattering and potential scattering was assumed for the total cross section. (auth)

5470 INTEGRAL STABILITY OF NONLINEAR TRANSPORT. **Mueller, K.-H. (CCR-EURATOM, Ispra, Italy). Atomkernenergie, 11: 421-2(1966).**

A criterion is developed for the integral stability of the solution of the nonlinear transport equation. The method can be applied to the neutron-density equations for a reactor, as well as other quantities which obey a transport equation. (S.F.L.)

5471 MINIMUM PRINCIPLES IN MULTIGROUP DIFFUSION THEORY. **Breitenhuber, L. (Technische Hochschule, Graz). Atomkernenergie, 11: 437-40(1966). (In German).**

For the system of diffusion equations for N groups, an equivalent differential equation of order 2N is derived. The identity of Cayley between powers of a matrix is used to eliminate the fluxes but one in a general symmetrical way. This equation is satisfied by all of the N fluxes and N adjoint fluxes and is Euler's equation of a minimum principle. The excess reactivity is proved to be the minimum value of one of these variational expressions with allowance for arbitrary variations inside a volume with fixed boundary values. (auth)

5472 SOME REMARKS TO THE DYNAMICS OF THERMAL NEUTRONS. **Bucci, P. (CAMEN, Pisa, Italy). Atomkernenergie, 11: 435-6(1966). (In German).**

The experimental observation of the behavior of thermal neutrons in accelerated motion in an S′ system was performed. The analysis is effected initially in the general case of a thermal source and two fissionable targets rigidly connected to the S′ system; arranged first vertically and then parallelly to the direction of motion. The calculations concern the limiting case of an acceleration of 2.2 km/sec^2 of the S′ system. A K_{ex} factor equal to unity, of the reactor, corresponds to this value of acceleration. For lesser values of the acceleration, calculations which are not reported, show that the kinetics of the reactor have decisively altered. (auth)

5473 MULTIPLICATIVE TRANSPORT PROCESSES IN ONE DIMENSION. **Brockwell, P. J. (Argonne National Lab., Ill.). J. Math. Anal. Appl., 16: 173-87(Oct. 1966).**

A model for neutron multiplication in a one-dimensional rod is outlined in which a random number, ν, of neutron pairs emerges from each collision (ν neutrons moving in each direction) in addition to the parent neutron which continues to move with its original direction of motion. (D.C.W.)

5474 TIME AND SPACE EIGENVALUES OF THE BOLTZMANN EQUATION WITH A SYNTHETIC THERMALIZATION KERNEL. **Williams, M. M. R. Nucl. Sci. Eng., 26: 262-70(1966).**

The time and space eigenvalues of the Boltzmann equation have been obtained, particular attention being given to those eigenvalues which lie close to the limit point. This has been possible by the use of a synthetic kernel, which converts the usual integral equation to a differential one: the solution of this equation is obtained by the W.K.B. method. Results have been obtained for the infinite- and finite-medium time eigenvalues in the gas model approximation. The eigenvalues of the scattering operator have been shown to be infinite in number also for the gas model. For the space eigenvalues it has been shown that, for a proton gas, only the fundamental exists, all higher eigenvalues are absent. It is found that as the mass of the gas increases, more space eigenvalues appear, but for any gas of finite mass these are finite in number. (auth)

5475 APPROXIMATION FOR THE CALCULATION OF THE GENERALIZED FIRST-FLIGHT COLLISION PROBABILITY. **Takahashi, Hiroshi. Nucl. Sci. Eng., 26: 254-61(1966).**

The method for calculating the generalized first-flight collision probability in a lattice system with a certain total cross section by the exact generalized first-flight collision probability in a system of the same geometry, having a different standard total cross section, is presented. The time required to calculate the multigroup integral transport problem, can be reduced greatly using this approximation; a large part of the time is consumed by the numerical integral calculation of the collision probabilities in all the energy groups. It is proved that the approximate collision probabilities obtained satisfy the conditions, i.e., the neutron conservation and the reciprocity relation. It is also shown by numerical calculation that the zero'th approximation using the first-flight collision probability gives very good values in the isolated or latticed systems. (auth)

5476 METHOD OF CALCULATING RESONANCE ABSORPTION IN A CIRCULARIZED CELL. **Kier, P. H. Nucl. Sci. Eng., 26: 230-6(1966).**

A method of calculating resonance absorption in a rod in a two-region circularized cell is developed. The method uses space- and lethargy-dependent neutron sources and, thus, includes overlapping and interference effects. An energy range of interest is divided into extremely narrow intervals of equal lethargy width. For each interval, the source distribution in each region is taken to be a three-term polynomial. By using this form for the source and the assumption that neutrons enter the rod isotropically, we obtain the reaction rates and the flux distribution for the interval. The reaction rates are used to obtain resonance integrals; the flux distribution is used to get the source distribution for lower energies. Calculations of the errors introduced into the resonance integral of the two closely spaced ^{232}Th resonances by the assumption of flat sources are given, as well as calculations of the effects of interference in UO_2-ThO_2 mixtures, which lie within the errors of the experimental results obtained by Foell. (auth)

5477 PULSED NEUTRON MEASUREMENTS IN GRAPHITE. **Jauho, P.; Aaltonen, R. (Inst. of Tech., Helsinki). Acta Polytech. Scand., Phys. Nucl. Ser., No. 40, 5-18(1966).**

Pulsed-neutron measurements in graphite were considered both theoretically and experimentally. The existence of a critical buckling in a crystalline, solid moderator was anticipated, and only sizes larger than those corresponding to the critical buckling were used in the analysis. The diffusion parameters obtained for a 1.69–g/cm^3 reactor-grade graphite were obtained. The local decay constants as a function of the delay time from the beginning of the neutron pulse show a pronounced plateau only in the event that the decay constant for the asymptotic mode does not exceed a value of about 2600/sec. This indicates the possible validity of Corngold's theorem even in the case of a crystalline solid. (S.F.L.)

5478 CROSS SECTION OF H ATOMS IN BENZENE, DIPHENYL, O- AND M-TERPHENYL. **Saad, Masoud (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atomkernenergie, 11: 431-2(1966). (In German).**

The total neutron cross-section of protons in solid and liquid diphenyl was measured in the region between 0.02 and 0.5 eV at the neutron crystal spectrometer at the FRG 1. The cross section for the liquid is slightly lower than that for the solid in the energy range between 0.02 and 0.04 eV. This general behavior is to be expected because of the more tightly bound hydrogen atoms in the solid dephenyl. A subthermal beam of neutrons with energy 0.0018 eV was obtained by total reflection from iron plates. The total cross section of C_6H_6, $C_{12}H_{10}$, and $C_{18}H_{14}$ were measured as a function of temperature between −60°C and +180°C. The cross sections show discontinuities at the phase transitions, at which the cross section for the liquid is higher than that for the solid. The discontinuity at the melting point arises mainly from the dispersion of the molecular binding. (auth)

5479 ON THE FOUNDATION OF THE BOLTZMANN EQUATION OF NEUTRON TRANSPORT THEORY. **Meyer, K. (VEB Atomkraftwerk Rheinsberg, Berlin). Kernenergie, 9: 225-7(July 1966). (In German).**

An outline of the derivation of the Boltzmann equation of neutron transport theory from quantum mechanical principles by a technique similar to the Green's function method is given. Some questions related to the connection of the Boltzmann equation and the master equation, which one gets in the first step, are presented. (auth)

5480 NEUTRON GENERATOR. **Arakawa, Kasuo. (to Matsushita Electric Ind. Co., Ltd.). Japanese Patent 1965-26517. Nov. 17, 1965. Filed July 22, 1963.**

A neutron generator is proposed which has an extremely high efficiency of producing neutrons. Gas molecules impinge upon one another in a discharge tube to produce neutrons by such reactions as T(d,n)He, etc. Thus, the energies received by ion molecules are used only in the neutron-producing nuclear reactions, without being wasted in collisions with other metal atoms as in conventional devices. A sealed discharge tube with anode and cathode is filled with deuterium and tritium gases, which take part in the neutron-producing reactions. Both the electrodes are connected to a pulsed voltage generator. The gases in the tube are ionized by a discharge between the electrodes, and are then accelerated within the tube; neutrons are produced by the collisions with other molecules in the discharge tube. (NSA of Japan)

5481 FAST NEUTRON GENERATOR. Nakai, Kiyoshi. (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1965-27278. Nov. 30, 1965. Filed Oct. 7, 1964.

A fast-neutron generator is proposed in which the neutron fluxes within the inner tube can be increased, thereby increasing the efficiency of irradiation of a sample material placed in the inner tube. The neutron generator consists of the following: an outer cylindrical body; an inner tube, with a thermal-neutron absorbing material imbedded in the tube wall, in which a sample material is placed for the fast-neutron irradiation; and a plurality of concentrical cylindrical bodies of different diameters, containing nuclear fuel, located (with some space between) between the outer cylindrical body and the inner tube. (NSA of Japan)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 5348, 5403, 5552, and 5591.

5482 (AD-641998) DEUTERON ELASTIC SCATTERING FROM ^{3}He AND ^{3}H. Tombrello, T. A.; Spiger, R. J.; Bacher, A. D. (California Inst. of Tech., Pasadena). Oct. 1965. Contract Nonr-220(47). 23p. CFSTI $3.00 cy, $0.65 mn.

The elastic scattering of deuterons from ^{3}He and ^{3}H was studied for bombarding energies up to 11 MeV. The excitation curves obtained show a broad resonance in the scattering cross section corresponding to an excitation energy of 20 ± 0.5 MeV in both ^{5}He and ^{5}Li. These data together with ^{3}H(d,n)^{4}He and ^{3}He(d,p)^{4}He data from other sources tend to indicate that D-waves are responsible for the anomaly. (auth)

5483 (ANL-7125, pp 237-40) NUCLEAR CONSTANTS. Stupegia, D. C.; Tevebaugh, A. D.; Bingle, J. D. (Argonne National Lab., Ill.).

Measurements of neutron cross sections of materials important to the fast reactor program were continued. Radiative capture cross sections of ^{141}Pr, ^{175}Lu, ^{139}La, and ^{176}Yb have been measured for monoenergetic neutrons in the fast reactor energy region. Samples of uranium and plutonium isotopes are undergoing irradiation in EBR-II in experiments designed to measure the ratio of the capture and fission cross sections of these isotopes. (P.C.H.)

5484 NEUTRON-PROTON RADIATIVE CAPTURE AT 14.4 MeV. Tudoric-Ghemo, J. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys., A92: 233-40(1967).

The energy spectrum of deuterons from the H(n,d)γ reaction at 14.4 MeV was measured with a counter telescope. The cms differential cross section of this reaction was deduced from the deuteron energy distribution. A least-squares fit yielded a total cross section of σ = 30.6 ± 1.8 μb, which is about 10% larger than the theoretical prediction. The isotropy ratio a/b was found to be 0.08 ± 0.06 and the asymmetry parameter was determined to be d/b = 0.12 ± 0.09. (auth)

5485 ENERGY LEVELS OF THE FOUR NUCLEON SYSTEM. Kramer, P.; Moshinsky, M. (Univ., Mexico, Mexico City). Phys. Lett., 23: 574-6(Dec. 5, 1966).

The levels of the four-nucleon system are calculated taking harmonic oscillator states with up to two quanta. The center of mass motion is explicitly eliminated; and the effects of kinetic energy, Serber force and two-particle spin-orbit coupling are discussed. (auth)

5486 CLOUD CHAMBER MEASUREMENT OF THE POLARIZATION OF d-D NEUTRONS AT E_d = 350 keV. Mulder, J. P. F. (Rijksuniversiteit, Groningen, Netherlands). Phys. Lett., 23: 589-90(Dec. 5, 1966).

The polarization of neutrons from the reaction ^{2}H(d,n)^{3}He, at a reaction angle of 46.5° and a deuteron energy of 350 keV was determined to be −13.8 ± 1.4% (phase shifts of Austin et al.). (auth)

5487 TENSOR POLARIZATION IN d-α SCATTERING. McIntyre, L. C.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys., A6702: 369-81(1967). (COO-7-398).

The tensor polarization parameters $\langle T_{20}\rangle$, $\langle T_{21}\rangle$, and $\langle T_{22}\rangle$ of deuterons scattered from ^{4}He were measured in the energy range 2 to 9 MeV. Measurements were made at laboratory scattering angles of 45°, 60°, 75°, and 90°. The ^{3}He(d,p)^{4}He reaction was used as the polarization analyzer. The largest observed polarization occurs at 5.35 MeV, 60°, where $\langle T_{20}\rangle$ is 64% of its maximum possible value. Large values of $\langle T_{22}\rangle$ were also observed, but $\langle T_{21}\rangle$ was essentially zero except below 5 MeV. An investigation into the analyzing power of the ^{3}He(d,p)^{4}He reaction is presented. (auth)

5488 PHASE SHIFT ANALYSIS OF d-α SCATTERING. McIntyre, L. C.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys., A6702: 382-98(1967). (COO-7-399).

The phase shifts for d-α scattering were determined between 2 and 10 MeV from measured differential cross sections and tensor polarization parameters. Complex phase shifts of orbital angular momentum $l \leq 2$ were used, and coupling between the s- and d-wave J = 1 phase shifts was taken into account. The coupling was found to be small. The existence of the broad $J^\pi = 2^+$ and $J^\pi = 1^+$ resonances was confirmed and resonance parameters were determined. The real and imaginary parts of the p-waves remain less than 20° which provides strong evidence against the existence of the previously reported T = 0 p-wave triplet in ^{6}Li. Comparison of the phase shifts with optical model phase shifts shows that all essential features of d−α scattering below 10 MeV can be described by a simple potential with an $l \cdot s$ term. The potential depth is about twice that for p−α scattering but the spin orbit interaction is considerably weaker for the d−α than for the p−α interaction. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 5435, 5506, 5520, 5552, 5565, 5567, 5580, and 5591.

5489 (JINR-P4-2936) ANALOGOVYE SOSTOYANIYA YADER S A = 16. (Analogue States of A = 16 Nuclei). Vashakidze, I. Sh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 17p. (In Russian). Dep. mn.

The low-lying T = 1 levels for A = 16 nuclei were calculated taking into account the exact nucleon-nucleon interaction and Coulomb forces. The agreement with experiment is satisfactory. (auth)

5490 (ORNL-TM-1549) SOME EFFECTS OF A MODIFIED EVAPORATION PROGRAM ON CALCULATIONS OF RADIOCHEMICAL CROSS SECTIONS AND PARTICLE MULTIPLICITIES FOR PROTONS ON CARBON AND ALUMINUM TARGETS. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Nov. 14, 1966. Contract W-7405-eng-26. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Previous calculations of radiochemical cross sections by the usual cascade-evaporation approach for 25- to 400-MeV protons incident on aluminum and carbon were repeated to determine the effects of some of the modifications made by Peelle and Aebersold in the evaporation program originally coded by Dresner. For aluminum, the effect is to improve the agreement of the calculated cross section with experiment for the two reactions calculated, but for carbon the modifications resulted in no change in one case and decreased the agreement in another case. The most significant change in the particle multiplicities is that the average number of neutrons evaporated in the higher energy reactions with aluminum is about 25% higher when the modified program is used. (auth)

5491 DIFFERENTIAL CROSS SECTIONS OF ^{12}C(d,p$_1$)^{13}C AND ^{10}B(d,p)^{11}B BELOW E_d = 3.0 MeV. Poore, R. V. (Univ. of North Carolina, Chapel Hill); Shearin, P. E.; Tilley, D. R.; Williamson, R. M. Nucl. Phys., A92: 97-122(1967).

In order to investigate the characteristics of low Q-value deuteron stripping reactions, differential cross sections of ^{12}C(d,p$_1$)^{13}C (3.09 MeV state) were measured at 11 bombarding energies between E_d = 2.088 and 0.900 MeV; and differential cross sections of ^{10}B(d,p)^{11}B, for the fourth, sixth, seventh, eighth, ninth, tenth and eleventh excited states were measured at six bombarding energies between E_d = 3.000 MeV and 1.750 MeV. An examination of the ability of the plane-wave, distorted-wave and Coulomb-wave Born approximation theories to predict the shape as well as the absolute cross sections was made. Scattering angles at which the angular distributions break away from the Butler curves are compared with polology predictions. (auth)

5492 ELASTIC SCATTERING OF 26.3 AND 30 MeV PROTONS. Watson, D. L.; Lowe, J.; Dore, J. C.; Craig, R. M.; Baugh, D. J. (Univ. of Birmingham, Eng.). Nucl. Phys., A92: 193-208(1967).

Angular distributions are presented of the relative differential cross sections and polarizations of 26.3-MeV protons elastically scattered by Ca, ^{58}Ni and ^{208}Pb. The angular distribution of polarization produced in the elastic scattering of 30-MeV protons by ^{9}Be is also presented. Previously published measurements of the polarization produced in the elastic scattering of 30-MeV protons by Ca, ^{58}Ni, ^{60}Ni and ^{208}Pb are extended to larger scattering angles

(110–160°). The results are discussed in terms of the optical model. (auth)

5493 STUDY OF LIFETIMES OF NUCLEAR LEVELS BY DOPPLER BROADENING ATTENUATION USING A Ge(Li) GAMMA-RAY SPECTROMETER. **Catz, A. L.; Amiel, S. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Phys., A92: 222-32 (1967).**

The half lives of the first excited levels of ^{7}Li(477 keV) were studied by means of the Doppler broadening of the gamma lines emitted following the nuclear reactions ^{10}B(n,α)^{7*}Li and ^{9}Be(α,n) ^{12*}C, respectively. Measurements were carried out with a Ge(Li) spectrometer. The values obtained were $T_{1/2}$ = 92 ± 11 fs for de-excitation of ^{7*}Li and $T_{1/2} \leq 33 \pm 7$ fs for the de-excitation of ^{12*}C. A general mathematical expression was derived for the Doppler broadening. (auth)

5494 POLARIZATION AND CROSS-SECTION MEASUREMENTS OF PROTONS SCATTERED BY ^{14}N. Drigo, L.; Manduchi, C.; Nardelli, G. C.; Russo-Manduchi, M. T.; Tornielli, G.; Zannoni, G. (Univ., Padua). Nuovo Cimento (10), 45B: 206-13 (Oct. 11, 1966).

A systematic investigation has been carried out on the angular dependence of the polarization resulting from the elastic scattering of protons by ^{14}N, at center-of-mass angles from 42.3 to 142.3° and proton energies between 3.0 and 4.8 MeV. A contour map of percent polarization, as a function of energy and laboratory angle, is reported. New cross-section data between 2.6 and 4.8 MeV are also given. (auth)

5495 DWBA CALCULATIONS OF THE KNOCK-OUT PROCESS IN DEUTERON STRIPPING REACTIONS ON ^{10}B AND ^{13}C. Barz, H. W. (Central Inst. for Nuclear Research, Rossendorf, Ger.). Nucl. Phys., A6702: 262-72(1967).

An important effect of the Pauli principle in direct reactions is the knock-out process. It is calculated in DWBA with a zero-range force for the nucleon–nucleon interaction. The nuclei are described in the shell model with intermediate coupling. In the case of the ^{10}B(d,p_1)^{11}B reaction, the knock-out process produces the correct order of magnitude of the cross section. In the ^{13}C(d,n)^{14}N reaction, the coherent overlap of the knock-out and stripping amplitudes gives a smaller cross section than the stripping amplitude alone. (auth)

5496 SCATTERING OF 10 MeV NEUTRONS BY ^{6}Li AND ^{7}Li. Cookson, J. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Dandy, D.; Hopkins, John C. Nucl. Phys., A6702: 273-91(1967). (LA-DC-8023).

The neutron scattering cross sections for ^{6}Li and ^{7}Li were measured for 10-MeV incident energy, using a time-of-flight spectrometer. Differential cross sections were obtained at seven angles for ^{6}Li and five for ^{7}Li between 27.5° and 151° in the laboratory system. The elastic cross section of ^{6}Li is 1030 ± 100 mb and the total nonelastic cross section giving neutrons of more than 2 MeV is 394 ± 46 mb. For ^{7}Li the elastic plus inelastic cross section to the 0.478-MeV state is 1268 ± 190 mb and the nonelastic cross section giving neutrons of more than 2 MeV is 360 ± 53 mb. After the addition of the estimated yield of neutrons with energies less than 2 MeV and other unobserved processes, these results are consistent with available measurements of the total cross sections. (auth)

5497 PARITY IMPURITIES IN ^{19}F. Maqueda, E. (Univ. of Sussex, Brighton, Eng.). Phys. Lett., 23: 571-2(Dec. 5, 1966).

The effect of nuclear parity impurities in the 110-keV transition in ^{19}F is investigated. (auth)

5498 THE SCATTERING OF PROTONS ON Li, Be, AND C AT 100 MeV. Mark, S. K.; Portner, P. M.; Moore, R. B. (McGill Univ., Montreal). Can. J. Phys., 44: 2961-71(Dec. 1966).

Elastic and inelastic scattering of protons on ^{7}Li, ^{9}Be, and ^{12}C was studied, using a 100-MeV proton beam. Differential cross sections for the various groups of scattered protons were measured over an angular range of 5 to 90° (lab). For proton groups resulting from a quadrupole excitation in the target nucleus, the angular distribution was found to increase at scattering angles less than 10°. Angular distributions corresponding to an octupole excitation were observed to decrease at small angles. The results were compared with existing data in this energy region. (auth)

5499 CORE DEFORMATION IN ^{6}Li ARISING FROM THE TENSOR FORCE. Freed, N. (Pennsylvania State Univ., University Park); Goldhammer, P. Phys. Lett., 23: 564-6(Dec. 5, 1966). (COO-1120-45).

The T = 0, J = 1, 2, and 3 positive-parity levels of a six nucleon system are calculated using single-particle orbitals derived from a deformed oscillator potential. Proper eigenfunctions of J^2 are projected through Hill–Wheeler integrals. Simplified forces are used so that the entire deformation is due to the tensor force. It is found that, to a very good approximation, all three levels may be generated from a single intrinsic function with constant size and deformation parameters. The derived level scheme indicates that the vector effects of the tensor force, previously calculated by second-order perturbation theory, are included in this model. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 5348, 5435, 5551, 5552, 5565, and 5566.

5500 (COO-1120-31) A STUDY OF EXCITED STATES OF ^{35}Cl BY THE ^{34}S(p,γ)^{35}Cl REACTION. Watson, D. D. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [1964]. Contract AT(11-1)-1120. 11p. Dep. mn. CFSTI $3.00 cy, 10.65 mn.

The energy levels of ^{35}Cl were investigated using the reaction ^{34}S(p,γ)^{35}Cl. Gamma spectra were observed at several resonances, and angular-distribution, triple-correlation, and polarization measurements were made. (D.C.W.)

5501 (INP-478/PL) A STUDY OF (α,d) REACTION ON ^{40}Ca NUCLEI. Benisz, J.; Grotowski, K.; Freindl, L.; Karcz, W.; Jasielska, A.; Panek, T.; Wiktor, S. (Institute of Nuclear Physics, Krakow (Poland)). May 1966. 12p. Dep.

The reaction ^{40}Ca(α,d)^{42}Sc was studied using an α-particle beam with an energy of 24.7 ± 0.1 MeV. Deuteron spectra were obtained by two independent techniques: magnetic analyzer and solid-state counter telescope. Transitions to the excited states of ^{42}Sc at 0.61, 1.50, 2.18, 2.93 and 3.73 MeV and a very weak transition to the ground state were detected. Angular distributions for transitions to the highly populated levels 0.61 and 1.50 MeV of the final nucleus were measured. Relative intensities of the observed transitions are discussed according to the selection rules for the two-nucleon-transfer reactions. (auth)

5502 (INP-492/PL) EXCITED STATES OF ^{75}As FOLLOWING THE DECAY OF ^{75}Se. **Gasior, M.; Niewodniczanski, H.; Potempa, A. (Institute of Nuclear Physics, Krakow (Poland)). Sept. 1966. 18p. Dep.**

The conversion electron spectra from the decay of ^{75}Se and electron-electron coincidences were investigated by means of a double, iron-free, toroidal beta spectrometer. The conversion electrons accompanying gamma transitions with energy 24, 66, 81, 97, 121, 136, 199, 265, 280, 304, 401, 572, and 618 keV were observed. The 77 keV transition and 188 and 203 keV transitions were not found. The conversion coefficients were determined. In order to locate the 81 keV transition in the level scheme, the coincidence experiment was made. (auth)

5503 (NYO-2897-17) NUCLEAR CHEMISTRY RESEARCH OF HIGH ENERGY NUCLEAR REACTIONS AT CARNEGIE INSTITUTE OF TECHNOLOGY. Annual Progress Report, 1965-1966. (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Chemistry). June 1, 1966. Contract AT(30-1)-2897. 89p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The mechanisms contributing to (p,xn) reactions were investigated in a systematic study of (p,xn) reactions on nuclei with A = 56 to 126. The dependence of Cd(p,xn)In reactions at 400 MeV on the target neutron number was also studied; the production cross sections and decay properties of ^{107}In, ^{109}In, and ^{111}In were measured. The production of ^{111}In was investigated as a function of the mass numbers of cadmium isotopes and of the proton energy between 70 and 400 MeV. In addition, the (p,2p) reaction on ^{112}Cd, ^{113}Cd and ^{114}Cd at 400 MeV was studied; the decay properties of ^{111}Ag, ^{112}Ag, and ^{113}Ag were measured as well as the reaction cross sections. Excitation functions for the reactions ^{25}Mg(p,2p)^{24}Na and ^{26}Mg(p,2pn)^{24}Na were measured between 100 and 400 MeV in a study of mechanisms involved in (p,2pxn) reactions. The isomer ratios of ^{117}In produced in ^{118}Sn(p,2p)^{117}In reactions at 330, 430, 590, and 18,000 MeV were also measured as were the reaction cross sections. The recoil properties and formation cross sections of several Pd and Ag nuclides formed in the bombardment of natural In and Ag by 200- to 400-MeV protons were measured, and the cross sections and recoil properties of the reactions ^{103}Rh(p,pπ^-)^{103}Pd and ^{103}Rh(p,pπ^+)^{103}Ru at 18 GeV were experimentally determined. (D.C.W.)

5504 NUCLEAR SPECTROSCOPY IN THE s-d SHELL REGION. **Endt, P. M. (Univ., Utrecht). Nuovo Cimento (1), 3: Suppl., 811-19(1965).**

Calculations were made in the A = 28 to 40 region using the intermediate-coupling many-particle shell model. The success obtained with these calculations, the problems they presented, and their possibilities as a starting point for further work are discussed. Recent studies of the resonance reactions (α,γ) and (α,p) made with the aid of the Utrecht 3-MeV Van de Graaff generator are described. Some of the results obtained are recorded. (J.S.R.)

5505 RADIOCHEMICAL PURIFICATION OF TIN AND THE HALF-LIVES OF ^{121}Sn, ^{123}Sn, ^{125}Sn, AND ^{125}Sb. Lawrence, F. O.; Daniels, W. R.; Hoffman, D. C. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Inorg. Nucl. Chem., 28: 2477-82(Nov. 1966). (LA-DC-7593).

A procedure is given for the separation and radiochemical determination of tin isotopes (in uranium) fission product mixtures at least 2 days old. The half-lives of ^{121}Sn, ^{123}Sn, ^{125}Sn, and ^{125}Sb were determined to be 26.85 ± 0.20 hr, 129.0 ± 0.5 days, 9.625 ± 0.025 days, and 2.81 ± 0.05 years, respectively. (auth)

5506 SPECTRA CALCULATIONS FOR THE POSITIVE-PARITY STATES OF DOUBLY EVEN NUCLEI IN THE 2s,1d SHELL. Stover, J. E. (Univ. of Texas, Austin). Nucl. Phys., A92: 209-21(1967).

The energy spectra of ^{18}O, ^{20}Ne, ^{24}Mg, ^{26}Mg and ^{28}Si are calculated for a Yukawa interaction potential with Serber mixing by approximating the nuclear wave functions as being the lowest-lying SU_3 states. The potential strength and length parameters are varied to obtain best fits to experimental data. Using the concept of interchanging particles and "holes," these results are reflected into the upper half of the 2s, 1d shell, and spectra of ^{30}Si, ^{32}S, ^{36}Ar and ^{38}Ar are obtained. (auth)

5507 THE KLL AUGER SPECTRUM OF MANGANESE. Lui, Y. Y.; Albridge, R. G. (Vanderbilt Univ., Nashville). Nucl. Phys., A92: 139-44(1967).

The KLL Auger spectrum of manganese (Z = 25) was measured from the electron capture decay of ^{55}Fe. The measured energies do not agree with values calculated semi-theoretically. The relative intensities of the groups of lines $KL_1L_{2,3}$ and $KL_{2,3}L_{2,3}$ agree within error limits with the theoretical values of Asaad and of Mehlhorn and Asaad; however for the individual line intensities the agreement is not good. (auth)

5508 PROPERTIES OF EXCITED STATES IN ^{34}S FROM STUDIES OF THE (α,γ) AND (α,n) REACTIONS ON ^{30}Si. Wiechers, G. (Univ. of Cape Town); McMurray, W. R.; Van Heerden, I. J. Nucl. Phys., A92: 175-92(1967).

The study of the $^{30}Si(\alpha,\gamma)$ reaction was extended up to E_α = 4.95 MeV, and the competing reaction $^{30}Si(\alpha,n)^{33}S$ was simultaneously investigated from its threshold at 3.97 MeV up to 4.95 MeV. Twenty-nine additional compound nucleus resonances were observed. For seven of these states, and ten others at energies E_α = 3.25 to 4.25 MeV, the spins and parities were determined by angular distribution and correlation measurements. Angular distributions of the neutrons emitted at resonant energies do not seem to conform with compound-nucleus formation. (auth)

5509 A STUDY OF ^{27}Mg BY MEANS OF THE $^{26}Mg(d,p\gamma)^{27}Mg$ REACTION. Lacambra, J. M.; Tilley, D. R.; Roberson, N. R. (Duke Univ., Durham, N. C.). Nucl. Phys., A92: 30-56(1967).

The low-lying excited states of ^{27}Mg were studied by means of $^{26}Mg(d,p\gamma)^{27}Mg$ angular correlation measurements at deuteron bombarding energies of 3.00, 3.37, and 4.28 MeV. Analysis by plane-wave stripping theory led to assignments $J^\pi = {}^3\!/_2{}^+, {}^5\!/_2{}^+, {}^5\!/_2{}^+, {}^3\!/_2{}^-$, and ${}^3\!/_2{}^+$ for the states of ^{27}Mg at 0.984, 1.69, 1.94, 3.56, and 3.76–3.78 MeV, respectively. Rough values for the multipole-mixing parameter δ of the gamma rays were deduced. Analysis of the results, using the extreme single-particle collective model suggests that ^{27}Mg is a prolate spheroid with a nuclear deformation $\eta \approx 2$. The ground state is assumed to occupy Nilsson orbit 9, and the 0.984- and 1.95-MeV levels are assumed to be the second and third members of the rotational band based on the ground state. A consistent set of model parameters was determined which gives reasonable agreement with the observed energy spacings, branching ratios, and multipole-mixing parameters and with previously measured spectroscopic factors. The 1.69-MeV state is conjectured to be a state formed by core excitation. (auth)

5510 ON THE MEANING OF THE (n,2n) REACTION CROSS SECTION. Hille, P.; Karlik, B.; Tagesen, S. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 174: No. 1-4, 11-31(1965). (In German).

The experimental data on the (n,2n) reaction cross section on nuclei with A between 20 and 100 and at neutron energies between 14 and 15 MeV were surveyed, and the systematics of the values were studied. The theoretical treatment of the (n,2n) cross section uses two simplifying assumptions: the outgoing neutrons have an energy spectrum of the Maxwellian form; and the emission of two neutrons always occurs when energetically possible. The validity of these assumptions is examined. (L.B.S.)

5511 PRECISION MEASUREMENTS OF STANDARD GAMMA-RAY ENERGIES. White, D. H.; Groves, D. J. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Phys., A6702: 453-9(1967). (UCRL-14996).

Several useful secondary standard gamma-ray energies have been measured with a high-resolution Ge(Li) detector. By intercomparing close-lying full-energy peaks and pair-escape peaks, precise energy values are determined. The resulting values in keV, based on the annihilation gamma energy 511.003 ± 0.005 keV and standard gamma energies of ^{182}Ta, ^{192}Ir, ^{198}Au, and ^{137}Cs, are as follows: ^{141}Ce–145.41 ± 0.03; ^{51}Cr–320.11 ± 0.03; ^{69m}Zn–438.70 ± 0.10; ^{60}Co–1173.25 ± 0.08; ^{22}Na–1274.58 ± 0.10; ^{41}Ar–1293.76 ± 0.14; ^{60}Co–1332.56 ± 0.05; ^{52}V–1434.19 ± 0.05; ^{124}Sb–1691.24 ± 0.08; ^{28}Al–1778.70 ± 0.17; ^{88}Y–1836.17 ± 0.12. (auth)

5512 LIFETIME OF THE $3/2^+$, 1.013 MeV STATE AND THE EXCITED-CORE MODEL OF ^{27}Al. Evers, D.; Hertel, J.; Retz-Schmidt, T. W.; Skorka, S. J. (Univ., Hamburg). Nucl. Phys., A6702: 472-80(1967).

Nuclear resonance fluorescence scattering was observed to measure the lifetime of the second excited state in ^{27}Al at 1.013 MeV. The $^{27}Al(p,p'\gamma)$ reaction in a solid aluminum target served as a Doppler-broadened gamma source. The scattering experiment yielded a mean life of t_m = 2.2 ± 0.3 ps, corresponding to a magnetic dipole transition strength of $(11.5 \pm 1.6) \cdot 10^{-3}$ Weisskopf units. The low-lying levels of ^{27}Al are discussed in detail in terms of the excited-core model, taking a mixing of the two ${}^3\!/_2{}^+$ excited states into account. Agreement between the model predictions and the experimental data is obtained for a 15% quasi-particle admixture to the ${}^3\!/_2{}^+$ state at 1.013 MeV. To fit the energies of the multiplet states, the core-hole interaction must contain multipoles of orders up to four. (auth)

5513 THE GROUND STATE AND THE ODD-PARITY SPECTRUM OF ^{40}Ca. Gillet, V.; Sanderson, E. A. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A6702: 292-304(1967).

The energies and eigenvectors of the odd-parity states of ^{40}Ca are given in the framework of the particle-hole model, using recently determined single-particle energies. The wave function of the ground state of ^{40}Ca is evaluated within the framework of the quasi-boson approximation. It appears to be only 30% a pure shell-model state. Comparison is made between the theoretical occupation numbers and the experimental spectroscopic factors obtained in one-nucleon transfer reactions. (auth)

5514 ANGULAR CORRELATION MEASUREMENTS IN ^{22}Ne. Buhl, S.; Pelte, D.; Povh, B. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A6702: 319-28(1967).

The 4.47, 5.14, 5.63, and 6.35 MeV states in ^{22}Ne were studied by the $^{19}F(\alpha,p\gamma)^{22}Ne$ reaction at an alpha bombarding energy of 12.55 MeV. The gamma decay of these states was determined, and possible spin assignments were obtained using method II of Litherland and Ferguson. The spins found are J(4.47 Mev) = 2, J(5.14 MeV) = 2(1, 3, 4), J(5.63 MeV) = 3 and J(6.35 MeV) = 6. For most gamma transitions, the multipole mixing ratio is given. (auth)

5515 GAMMA RADIATION FROM ^{71}Zn AND ^{71m}Zn. Li, A. C. (Yale Univ., New Haven); Monaro, Sergio. Nucl. Phys., A6702: 353-64(1967). (YALE-2726-H-83).

Gamma-ray spectra from the decay of the ^{71}Zn isomeric pair were studied using a lithium-drifted germanium detector. The sources were produced from enriched zinc targets. The decay of the 4.0 ± 0.1 h ^{71}Zn isomer gave rise to gamma rays of 122, 143, 387, 488, 512, 596, 620, 752, 772, 963, 987, 1008, 1107, and 1475 keV. The gamma-ray spectrum from the 2.5 min ^{71}Zn isomer, which was investigated only up to an energy of ≈650 keV, showed a very strong 512-keV transition. Two weak transitions of approximately 122 and 390 keV were also detected. The experimental results are summarized in a tentative decay scheme. The well-established levels in ^{71}Ga are at 512, 1108, and 1495 keV. The half life of the 1495 keV level in ^{71}Ga, measured by the delayed coincidence method, was found to be $(1.54 \pm 0.15) \times 10^{-10}$ sec. (auth)

5516 A Ge(Li) COUNTER INVESTIGATION OF THE GAMMA-RAY DECAY OF ^{28}Si PRODUCED IN THE REACTION $^{27}Al(p,\gamma)^{28}Si$. Azuma, R. E.; Carlson, L. E.; Charlesworth, A. M.; Jackson, K. P.; Anyas-Weis, N.; Lalovic, B. (Univ. of Toronto). Can. J. Phys., 44: 3075-81(Dec. 1966).

A large (17 cm^3) lithium-drifted germanium detector was used to observe γ deexcitation of ^{28}Si produced at several proton resonances in the $^{27}Al(p,\gamma)^{28}Si$ reaction. The decay schemes were deduced and were compared with those previously published. A detailed account is given for the E_p = 992-keV resonance only. (auth)

5517 COLLECTIVE CORRELATIONS IN THE GIANT RESONANCE OF ^{60}Ni. Seaborn, J. B.; Drechsel, D.; Arenhoevel, H.; Greiner, W. (Univ., Frankfurt am Main). Phys. Lett., 23: 576-8(Dec. 5, 1966).

The theory of collective correlations is applied to the giant dipole resonances of ^{60}Ni. The results are in good agreement with (γ,n) measurements. The theory is also compared with the pure particle-hole model as well as with the dynamic collective theory. (auth)

5518 A TEST OF M SUBSHELL CONVERSION COEFFICIENTS AT THRESHOLD ENERGIES. Amtey, S. R.; Hamilton, J. H.; Zender, M. J. (Vanderbilt Univ., Nashville). Phys. Lett., 23: 581-2(Dec. 5, 1966).

The M subshell ratios of the 2.23-keV E3 transition in ^{99m}Tc were measured to test calculations of conversion coefficients at threshold. The experimental and theoretical values agree. (auth)

5519 THE HALF-LIFE OF ^{87}Rb. McMullen, C. C.; Fritze, K.; Tomlinson, R. H. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 44: 3033-8(Dec. 1966).

The quantity of ^{87}Sr produced from the decay of ^{87}Rb during an accurately known period of time was determined. The analysis of the ^{87}Rb and the ^{87}Sr content of four different rubidium samples was performed by mass spectrometry. A value of $4.72 \pm 0.04 \times 10^{10}$ years was calculated from the results of the measurements for the half life of ^{87}Rb. (auth)

5520 EXCITATION FUNCTIONS FOR THE FORMATION OF ^{7}Be IN ^{3}He PARTICLE INDUCED REACTIONS ON C, N, O, F, Mg, Al, AND Si. Mikumo, T. (Tokyo Univ. of Education); Seki, R.; Tagishi, Y.; Furukawa, M.; Yamaguchi, H. Phys. Lett., 23: 586-8(Dec. 5, 1966).

Excitation functions of (^{3}He;^{7}Be,x) reactions on several light nuclei were measured. The shape of the excitation functions and the absolute cross section vary very much from one nucleus to another, reflecting the properties of individual target nuclei. (auth)

5521 INVESTIGATION OF THE ^{64}Zn STATES FED IN THE BETA DECAY OF ^{64}Ga. Konijn, J. (Instituut voor Kernphysisch Onderzoek, Amsterdam); Van Lieshout, R.; Deutsch, J. P.; Grenacs, L. Nucl. Phys., A6702: 439-52(1967).

A high-resolution Ge(Li) study of the ^{64}Ga decay supplemented by coincidence measurements has led to a new level scheme for ^{64}Zn. Five new 1^{+} levels above 4 MeV are found to be fed in the beta decay by allowed transitions. The reported level at 3.32 MeV is shown to be a complex of levels. The relevance of this work for the interpretation of beta-gamma circular polarization correlation experiments is briefly discussed. (auth)

5522 ANALYSIS OF (d,α) REACTIONS ON ISOTOPES OF IRON, NICKEL, AND COPPER. Hjorth, S. A. (Research Inst. for Physics, Stockholm). Ark. Fys., 33: 147-82(1966).

Enriched targets of ^{56}Fe, ^{58}Ni, ^{60}Ni, ^{63}Cu, and ^{65}Cu were bombarded with 15-MeV deuterons. Outgoing alpha particles were observed, and a number of new energy levels were found in the residual nuclei. An attempt was made to analyze the angular distributions in terms of the zero-range distorted-wave theory of two-nucleon transfer reactions. In order to account for the shape of the angular distributions it was necessary to use slightly larger form factors than was expected on physical grounds. The measured absolute cross sections were on the average about 4.4 times larger than those calculated. Relative intensities could be predicted within a factor of about ±2.5 at a 90% confidence level using only the lowest-order, shell-model configuration. The effect of including higher configurations was studied for the reaction ^{58}Ni(d,α)^{58}Co. When the $(1f_{7/2})_p^{-1}$ $(1f_{5/2})_n$ configuration was taken into account, strength was redistributed from the lowest states to states which should otherwise not be excited, and a slight improvement in the predicted relative intensities resulted. In spite of the large uncertainties in the predicted relative intensities, the difference in cross section between the various levels is often so large that tentative spin assignments can be made by intensity considerations. In particular, it was verv easy to locate the 5^{+} levels in the odd residual nuclei. (auth)

5523 ANALYSIS OF SOME DEUTERON-INDUCED REACTIONS IN ^{63}Cu AND ^{65}Cu. Hjorth, S. A.; Allen, L. H. (Research Inst. for Physics, Stockholm. Univ. of Pittsburgh). Ark. Fys., 33: 207-29(1966).

Enriched targets of ^{63}Cu and ^{65}Cu were bombarded with 15-MeV deuterons. Cross sections and angular distributions of the outgoing protons, deuterons, and tritons were measured both by magnetic analysis and by solid-state counters. Spectroscopic factors and l-values were assigned to many levels in the odd residual nuclei. From the observed l-values and from intensity considerations limitations were put on the spin for many of the observed levels. Quasiparticle energies and occupation probabilities were estimated and were found to be in rough agreement with the corresponding quantities for isotonic Ni isotopes. A crude δ-force calculation was made for the low-lying levels in the odd Cu isotopes, and the predicted energies and cross sections could be made to agree qualitatively with experiment. The measurement of the triton angular distributions was extended to back angles for the ^{65}Cu(d,t)^{64}Cu reaction in order to detect and make use of a j dependence in the triton angular distributions, but no j dependence was found. The cross sections for exciting the phonon states in ^{63}Cu and ^{65}Cu by means of a (d,d′) reaction were found to be proportional to the cross sections for exciting these levels through an (α,α′) reaction and also to the reduced electric transition rates. (auth)

5524 INVESTIGATION OF THE SIGNIFICANCE OF THE (n,2n) CROSS SECTION IN THE CASE OF ^{52}Cr. Tagesen, Siegfried; Hille, Peter. Oesterr. Akad. Wiss., Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 174: No. 1-4, 85-97(1965). (In German).

An investigation is made to determine the origin of the strong deviations from experimental values occurring in the (n,2n) cross sections calculated according to the Weiskopf formula. It is shown on the basis of a specific example, ^{52}Cr, that the origin of these deviations lies in the inadmissibility of the assumption that neutron emission always occurs from the second intermediate nucleus when energetically possible. It is pointed out that the part missing in the (n,2n) cross section is found in the (n,nγ) cross section. The hindrance of the neutron emission by the centrifugal barrier is shown to be insufficient to explain the observed deviation. A model representation given by Bloch is considered, which gives, especially in the region of light to medium-weight nuclei, a strong dependence of the level density on the symmetry parameter (N-Z). (L.B.S.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 4701, 5435, 5503, 5510, 5511, 5566–5568, and 5581.

5525 (AD-641463) QUEERNESSES IN THE DEFORMATION CHART. Abecasis, S. M.; Bosch, H. E.; Heras, C. A. (Instituto de Investigactione Aeronautica y Espacial, Buenos Aires (Argentina)). July 1966. 25p. CFSTI $3.00 cy, $0.65 mn.

The structure of the excited levels in some neutron-deficient barium isotopes is described. A comparison between results obtained experimentally and those theoretically predicted by several nuclear models is performed. The character of the collective transitional region to which these nuclides belong is thoroughly discussed; a relation is established with the competition between spherical and deformed shapes in different regions of the deformation chart. (auth)

5526 (AD-642319) GAMMA-RAY SPECTRA OF THE PRODUCTS OF FAST NEUTRON FISSION OF ^{235}U AND ^{238}U AT SELECTED TIMES AFTER FISSION. Bunney, L. R.; Sam, D. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 13, 1966. 46p. (USNRDL-TR-1076). CFSTI $3.00 cy, $0.65 mn.

The gamma spectra of fission products from the fast-neutron fission of ^{235}U and ^{238}U were measured at nine selected times after fission from 15 min to 3 days. The data were used to calculate 100 energy bin distributions of the absolute number of photons/fission-sec by means of absolute calibrations of the collimated NaI(Tl) detector. (D.C.W.)

5527 (AECL-2618) THE RATIO OF CAPTURE TO FISSION IN ^{235}U AND ^{239}Pu. Durham, R. W.; Hanna, G. C.; Lounsbury, M.; Bigham, C. B.; Hart, R. G.; Jones, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct. 1966. 16p. (CN-23/2). Dep. mn. AECL $0.50.

The neutron capture-to-fission ratio and the resonance integral of ^{235}U were measured together with the capture-to-fission ratio, absorption cross section, and fission cross section of ^{239}Pu. The measurements were performed in a thermal and epithermal flux. (D.C.W.)

5528 (AEET-257) THERMAL AND SIXTEEN GROUP CROSS SECTION DATA FOR ^{233}Pa, ^{234}U, AND ^{236}U. Singh, R. Shankar (Atomic Energy Establishment, Trombay (India)). 1966. 14p. Dep. mn.

The latest available nuclear data were collected for ^{233}Pa, ^{234}U, and ^{236}U, and recommended values of thermal cross sections and resonance integrals are given for these isotopes for use in thermal-reactor calculations in the analysis of thorium fuel cycles. Sixteen-group cross sections for studying fast systems based on the same fuel cycle were prepared. Accuracies in the data and the need for further measurements and improvements were specified. (auth)

5529 (AHSB(S)-R-109) PHOTON INTERACTION DATA IN THE U.K.A.E.A. NUCLEAR DATA LIBRARY. Hemmings, P. J.; Offord, Susan M. (United Kingdom Atomic Energy Authority, London (England). Authority Health and Safety Branch). 1966. 43p. Dep. BIS $1.40. HMSO 7s.

Photon-interaction data for 25 elements and water were collected for use in the UKAEA Nuclear Data Library. The methods of photon interaction are discussed with reference to transmission calculations. Tabulations are given of cross sections for each element, and the angular distribution for Compton scattering is given at 23 energies. The energy range considered is 0.01 to 20 MeV. (auth)

5530 (JINR-E7-2924) TERNARY FISSION OF ^{238}U INDUCED BY NEON IONS. Flerov, G. N.; Karamyan, S. A.; Kuznetsov, I. V.; Oganesyan, Yu. Ts.; Penionzhkevich, Yu. E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 13p. Dep. mn.

Ternary fission has been investigated while bombarding ^{238}U with 190-MeV ^{22}Ne ions. The ratio of the ternary fission cross section to the binary fission one is within the limits $5 \times 10^{-6} < \sigma_{3F}/\sigma_{2F} < 10^{-4}$. The total kinetic energy of the fission fragments is about 250 MeV. The experiments were performed in the 310-cm JINR cyclotron. (auth)

5531 (JINR-P-2704) SINTEZ I OPREDELENIE RADIOAKTIVNYKH SVOISTV NEKOTORYKH IZOTOPOV FERMIYA. (Synthesis and Determination of Radioactive Properties of Some Fermium Isotopes). Akap'ev, G. N.; Demin, A. G.; Druin, V. A.; Imaev, E. G.; Kolesov, I. V.; Lobanov, Yu. V.; Pashchenko, L. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 11p. (In Russian). Dep. mn.

The experimental results of ^{238}U and ^{235}U bombardment with accelerated ^{16}O nuclei are described. A collection technique of the nuclear reaction products by gas entrainment was used. The α decay then was registered by (Si + Au) detectors. The excitation functions of (^{16}O,xn) reactions were investigated. Four fermium isotopes with mass numbers of 250, 249, 248, and 246 were identified. The α-particle energies and half lives of these isotopes were measured. An internal beam of the JINR 310-cm cyclotron was used. (auth)

5532 (JINR-P-2938) O YADERNYKH SVOISTVAKH IZOTOPOV 102-go ELEMENTA S MASSOVYMI CHISLAMI 255 I 256. (Nuclear Properties of 102 Isotopes With Mass Numbers 255 and 256). Akap'ev, G. N.; Demin, A. G.; Druin, V. A.; Lobanov, Yu. V.; Fefilov, B. V.; Flerov, G. N.; Chelnokov, L. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 6p. (In Russian). Dep. mn.

New data are given for the half life (~2 min) and the energy (8.08 MeV) of the α particles for ^{255}No, which differ greatly from previously published values. The energy of the α decay of ^{256}No was measured for the first time and was found to be 8.58 MeV. (auth)

5533 (JINR-P7-2966) NOVYE IZOMERY ^{128m}La/^{130m}La. (New Isomers ^{128m}La and ^{130m}La). Noibert, V.; Brinkmann, Kh.; Rotter, Kh.; Aleksander, K.; Khaizer, Kh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1966. 17p. (In Russian). Dep. mn.

Two previously unreported isomeric states in ^{128}La and ^{130}La were observed. The isomeric state in ^{130}La identified from the cross bombardings ^{122}Sn + ^{14}N and ^{123}Sb + ^{12}C decays by a 95 ± 5 keV gamma transition with a half life of $9.2 \pm 0.5\ 10^{-3}$ sec. The isomeric state in ^{128}La excited via the heavy ion bombardments ^{118}Sn + ^{14}N, ^{119}Sn + ^{14}N, ^{120}Sn + ^{14}N, and ^{121}Sb + ^{12}C has a half life of 0.56 ± 0.05 sec and decays by emission of two gamma rays with 67.5 ± 0.5 and 104 ± 1 keV, respectively. To identify the activity, excitation functions were measured. They have the typical form of pure neutron evaporation. Other reactions of the type (^{14}N,axn) and (^{14}N,pxn) were excluded by properly chosen cross bombardments ^{116}Cd + ^{15}N and ^{120}Sn, ^{122}Sn + ^{12}C and critical absorption measurements of the x ray. (auth)

5534 (MLM-1251) WEAK ALPHA AND ELECTRON-CAPTURE DECAY IN ^{208}Po AND ^{209}Po. Hagee, G. R.; Lange, R. C.; McCarthy, J. T. (Mound Lab., Miamisburg, Ohio). May 20, 1965. Contract AT(33-1)-Gen-53. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The weak alpha and electron-capture decay modes of ^{208}Po and ^{209}Po were investigated. Previously unobserved alpha groups were found at 4.22 MeV with 2.44×10^{-4}% abundance in ^{208}Po decay and at 4.11 and 4.31 MeV with 5.66×10^{-4}% and 1.46×10^{-4}% abundances, respectively, in ^{209}Po decay. The 4.617-MeV alpha group in ^{209}Po was measured explicitly and found to have 0.48% branching. Electron-capture branchings in ^{208}Po and ^{209}Po were measured as 1.81×10^{-3}% and 0.263%, respectively. Predominant electron-capture feeding in ^{208}Po populates a 921 keV level in ^{208}Bi. The log ft. value of this transition was determined to be 13.7, in agreement with its assignment as a second forbidden transition ($\Delta l = 2$, $\Delta\pi$ = NO). Gamma-rays following electron-capture decay in polonium-208 were found at energies of 65, 291, 534, 565, 599, and 865 keV. Measurements of internal conversion coefficients of K to L + M shell conversion electron ratios on the 291, 534, 565, and 599 keV transition in ^{208}Po or 263 and 900 keV transitions in ^{209}Po show them to be pure M1 or mixed M1 + E2 transitions. (auth)

5535 (ORNL-P-2599) RATIO OF CAPTURE TO FISSION IN ^{239}Pu AT keV NEUTRON ENERGIES. Lottin, A.; Weston, L. W.; de Saussure, G.; Todd, J. H. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 17p. (CONF-661019-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

The neutron capture to fission ratio, α, was measured for ^{239}Pu for neutron incident energies from 20 to 600 keV. A pulsed beam of neutrons was collimated on a sample of plutonium placed in the center of a large hydrogeneous gamma-ray scintillator poisoned with gadolinium. A capture event in the sample was characterized by a single pulse of the scintillator due to the cascade of capture gamma rays, while a fission event was characterized by a pulse due to the prompt fission gamma rays followed, a few microseconds later, by additional pulses due to the gamma rays produced when the thermalized fission neutrons were captured in the gadolinium of the scintillator. Below 100 keV the neutron energies were measured by the time-of-flight technique with a resolution of 7 nsec/m. Above 100 keV approximately monoenergetic neutrons were used. Similar measurements were also performed on ^{235}U and the results are included for completeness. The uncertainties in the values of α obtained are approximately 10%. The data are consistent with measurements performed by other laboratories. (auth)

5536 β^- SPECTRUM OF ^{182}Ta WITH ENERGIES OVER 600 keV. Balalaev, V. A. (Mendeleev All-Union Scientific Research Inst. of Metrology, Leningrad); Dzelepov, B. S.; Moskvin, L. N.; Shestopalova, S. A.; Voinova, N. A. Nucl. Phys., A6702: 465-71 (1967). (In German).

The high-energy β spectrum of ^{182}Ta was studied using a low-background magnetic β spectrometer with $2\pi\sqrt{2}$ focusing. β transitions to levels 2^+ (100 keV) and 4^+ (329 keV) in ^{182}W were observed with maximum energies 1713 ± 3 keV and 1470 ± 20 keV. The intensities, which are 0.058 ± 0.006% and 0.096 ± 0.010% per decay, correspond to the values $\log ft = 12.98^{+0.05}_{-0.04}$ and $\log ft = 12.51^{+0.05}_{-0.04}$. The upper limit of the β-transition intensity to the ^{182}W ground state was estimated as $I_{1813} < 10^{-3}$% per decay (log ft > 14.8). (auth)

5537 A DETERMINATION OF THE MULTIPOLE MIXTURE OF THE K-FORBIDDEN 1095-keV TRANSITION IN ^{172}Yb. Kleinheinz, P.; Vukanovic, R.; Zupancic, M.; Samuelsson, L.; Lindstroem, H. (Uppsala Univ.). Nucl. Phys., A6702: 329-52(1967). (UUIP-452).

The K-shell conversion coefficient of the 1095-keV $\Delta K = 3$ transition in the decay of the 1174-keV isomeric state in ^{172}Yb has been determined using an electron-electron coincidence method. The result, $\alpha_K(1095) = 2.83(19) \cdot 10^{-3}$, requires the multipole mixture, 89(8)% E2 + 11(8)% M1. From directional correlation measurements of the 1095K−79L and 1095γ−79L cascades, the total particle parameter for the 1095K electrons was obtained. The measured value, $B_{2,K}^{(1)}(1095) = 0.85(12)$, is in agreement with the multipole mixture obtained from the conversion coefficient. The result is in conflict with γ-γ angular correlation measurements which suggest predominant M1 multipolarity for the 1095-keV transition. It is shown that this discrepancy cannot be removed by assuming anomalous conversion. Absolute transition rates of the five observed $\Delta K = 3$ interband transitions are compared with theoretical estimates. (auth)

5538 MASS SPECTROMETRIC MEASUREMENTS OF THE RATIO OF NEUTRON CAPTURE TO FISSION FOR ^{239}Pu AND ^{241}Pu, AND OF THE ABSORPTION AND CAPTURE CROSS SECTIONS OF ^{239}Pu, ^{240}Pu, AND ^{241}Pu, FOR MAXWELLIAN NEUTRONS. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 28: 2467-75(Nov. 1966). (AERE-R-5166).

Mixtures of highly enriched samples of ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu were irradiated for 295.6 days in the DIDO Reactor near the core. Neutron doses were monitored by cobalt metal wire. Neutron temperature was (116 ± 4°) with an unperturbed Maxwell–

Boltzmann distribution. Results are given for mass analyses of the samples, both before and after the irradiation. (S.F.L.)

5539 PRECISE MEASUREMENT OF THE ABSOLUTE INTENSITY OF GAMMA RADIATION FROM LOW-ENERGY TRANSITIONS FROM (n,γ) REACTIONS AND RADIOACTIVE DECAY WITH A CRYSTAL SPECTROMETER. Neumann, Horst A. (Technische Hochschule, Munich). Z. Naturforsch., 21a: 1328-43(Sept. 1966). (In German).

Direct and indirect methods for accurate measurement of absolute intensities of low-energy γ rays from neutron capture and radioactive decay by means of a crystal spectrometer are described. The 478-keV peak of ^{7}Li (target ^{10}B) is used in the direct method while the 412-keV peak of ^{198}Hg (target Au) is used in the indirect method. In addition the intensity calibration of the crystal spectrometer used in FRM (Munich Research Reactor), determination of the neutron capture rate, and corrections for γ and neutron self-absorption are discussed in some detail. Absolute γ-intensities per neutron capture or decay respectively were determined for a number of strong low-energy γ transitions in ^{104}Rh, ^{114}Cd, ^{150}Sm, ^{153}Sm, ^{152}Eu, ^{153}Eu, ^{154}Eu, ^{156}Gd, ^{158}Gd, ^{162}Dy, ^{163}Dy, ^{164}Dy, ^{165}Dy, ^{165}Ho, ^{166}Ho, and ^{168}Er. An accuracy of 2% was obtained in the most favorable cases. (auth)

5540 THE γ SPECTRA OF ^{95}Tc, ^{95m}Tc AND ^{96}Tc. Cesareo, R.; Langhoff, H.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 197: 426-34(1966). (In German).

The γ spectra of ^{95}Tc(20 h), ^{95m}Tc(62 d), and ^{96}Tc(4.3 d) were investigated using Li-drifted germanium counters. The observed γ transitions in the decay of ^{95}Tc and ^{95m}Tc are in agreement with earlier investigations except for 6 transitions at 204, 680, and 840 keV in ^{95}Tc and at 970, 1390, and 1630 keV in ^{95m}Tc reported previously which have not been confirmed. In the spectrum of ^{96}Tc new transitions at 437, 462, 1094, 1200, and 1505 keV were identified. The level scheme of ^{96}Mo is discussed with respect to these results. (auth)

5541 MOESSBAUER EFFECT IN ^{174}Yb: THE g_R-FACTOR OF LOW-LYING 2^{+} STATES. Muenck, E.; Huefner, S.; Prange, H.; Quitmann, D. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch., 21a: 1507-8(Sept. 1966). (In German).

The magnetic hyperfine splitting of the 76.5-keV gamma ray of ^{174}Yb in $YbCl_3 \cdot 6H_2O$ was measured using the Mössbauer technique with a Lu source. The results obtained were $g_R^{174} = 0.340 \pm 0.010$ and $g_R^{170}/g_R^{174} = 0.994 \pm 0.015$. (D.C.W.)

5542 THE EMISSION OF ALPHA PARTICLES AND TRITONS IN THE THERMAL NEUTRON FISSION OF ^{235}U. Marshall, M.; Scobie, J. (Scottish Research Center, East Kilbride). Phys. Lett., 23: 583-5(Dec. 5, 1966).

The yield and energy spectrum of α particles and tritons emitted in the thermal-neutron fission of ^{235}U were measured; an upper limit is set for the emission of ^{6}He nuclei. (auth)

5543 OBSERVATION OF THE OCTUPOLE SEPTUPLET OF ^{209}Bi IN INELASTIC PROTON SCATTERING. Hafele, J. C.; Woods, R. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett., 23: 579-81(Dec. 5, 1966).

Magnetic analysis of 21-MeV protons inelastically scattered from the 2.6-MeV octupole state of ^{206}Pb, ^{207}Pb, ^{208}Pb, and ^{209}Bi is reported. In the odd-A nuclei, this state splits into a close multiplet with the number of levels in agreement with the predictions of the weak coupling model. (auth)

5544 SPONTANEOUS FISSION OF ^{243}Am. Gvozdev, B. A.; Zakhvataev, B. B.; Kuznetsov, V. I.; Perelygin, V. P.; Pirozhkov, S. V.; Chudinov, E. G.; Shvetsov, I. K. Radiokhimiya, 8: 493-4 (1966). (In Russian).

The half-life for the spontaneous fission of ^{243}Am was measured. The preparation of Am is described. The results from four series of tests are tabulated and the mean spontaneous fission half-life was $2 \pm 0.5 \times 10^{14}$ years. The values of the constant spontaneous fission of ^{243}Am and ^{241}Am are close. The coefficient of prohibition with respect to even-even nuclei is 2.5×10^{-6}. (J.S.R.)

5545 ON THE FIRST EXCITED LEVEL IN ^{211}Bi. Gabrakov, S. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 19: 473-4 (1966).

The energy of the first excited state of ^{211}Bi was calculated assuming that the state is a single-proton $f_{7/2}$ state. The value obtained is about 2.5 times the experimental value, indicating that the state is not a single-proton $f_{7/2}$ state. (D.C.W.)

5546 ANALYSIS OF SOME DEUTERON-INDUCED REACTIONS IN THE INDIUM ISOTOPES. Hjorth, S. A.; Allen, L. H. (Univ. of Pittsburgh). Ark. Fys., 33: 121-46(1966).

Targets enriched in ^{113}In and ^{115}In were bombarded with 15-MeV deuterons, and outgoing protons, deuterons, and tritons were observed by magnetic analysis. Many previously unreported levels were found in the residual nuclei. By analysis of the stripping and pick-up angular distributions, the values of the orbital angular momentum of the transferred neutron were determined for a number of levels in ^{112}In, ^{114}In, and ^{116}In. From the observed l-values and from intensity considerations, limitations were put on the spin for many of these levels. Single-particle energies and occupation probabilities were obtained, and they were roughly the same as the corresponding isotopes of Sn with the exception of the $1g_{9/2}$ level which was much emptier and about 2 MeV higher in In than in Sn. The reason for this must be the interaction with the $1g_{9/2}$ proton hole but the predicted shift using a δ force residual interaction was only 0.4 to 1 MeV. An attempt was made to calculate the energy levels in the odd In isotopes using only diagonal matrix elements and a δ-force residual interaction. A qualitative agreement and a number of tentative spin assignments resulted. Four to five strongly excited states were observed around 1.3-MeV excitation in the ^{113}In(d,d′)^{113}In and ^{115}In(d,d′)^{115}In reactions. These states were interpreted as the phonon states which arise from the coupling of the $1g_{9/2}$ proton hole with the 2+ vibrational level of the Sn core. However, their intensities were not in agreement with the expected $2J_f + 1$ dependence. An attempt to account for both the energies and cross sections for these levels using a P_2 force residual interaction was unsuccessful. (auth)

5547 ANALYSIS OF SOME DEUTERON-INDUCED REACTIONS IN THE Sb ISOTOPES. Hjorth, S. A. (Univ. of Pittsburgh). Ark. Fys., 33: 183-205(1966).

Targets enriched in ^{121}Sb and ^{123}Sb were bombarded with 15-MeV deuterons, and outgoing protons, deuterons, and tritons were observed by magnetic analysis. Many previously unreported energy levels were found in the residual nuclei. By analysis of the stripping angular distributions, the orbital angular momenta of the transferred neutron were assigned to a number of levels in ^{122}Sb and ^{124}Sb. From the observed l-values and by intensity considerations, limitations were put on the spin for many of these levels. Quasiparticle energies and occupation probabilities were obtained; they were found to be roughly the same as in the corresponding isotopes of Sn. An attempt was made to account for the energy levels in the odd Sb isotopes by a nuclear structure calculation assuming only diagonal matrix elements and a δ-force residual interaction. A qualitative agreement and a number of tentative spin assignments resulted. The experimental spectra and the success of these simple calculations assuming pure configurations indicate that levels, where the odd proton is in a $2d_{5/2}$ or a $1g_{7/2}$ state, are relatively little mixed. The experimental cross sections for exciting the quadrupole vibrational levels in ^{121}Sb and ^{123}Sb by inelastic deuteron scattering were, in particular for the lower spin states, smaller than expected. An attempt was made to calculate the energy and cross section for these levels using a P_2 force residual interaction between the odd proton and the Sn core. The ground and the first excited state of the core and the $1g_{7/2}$, $2d_{5/2}$, $3s_{1/2}$, and $2d_{3/2}$ single-proton states were included in the calculation and some resemblance with the experimental data was obtained. (auth)

5548 FISSION YIELDS OF IODINE ISOTOPES 131 TO 135 IN THE SPONTANEOUS FISSION OF ^{238}U. Menke, Helmut; Herrmann, Guenter (Univ., Mainz). Radiochim. Acta, 6: 76-80 (Oct. 1966). (In German).

Cumulative yields of the iodine isotopes ^{131}I, ^{132}I, ^{133}I, ^{134}I, and ^{135}I were determined radiochemically for the spontaneous fission of ^{238}U. The iodine isotopes were separated after various times of formation from two uranyl chloride solutions containing 936 or 3400g of natural uranium and were counted in an anticoincidence counter. The decay curves were analyzed by use of a computer. (S.F.L.)

5549 MEASUREMENTS OF THE GAMMA RADIATIONS FROM ^{188}Re BY THE METHOD OF EXTERNAL CONVERSION. El-Nesr, M. S.; El-Haliem, A. Abd (Nuclear Physics Dept., Cairo). Atomkernenergie, 11: 497-502(1966).

A study of the relative intensities of the gamma rays from the decay of ^{188}Re to ^{188}Os was performed using the external conversion method. The photoelectrons from a uranium converter are analyzed in a high-resolution double-focusing beta-ray spectrometer. In order to obtain the relative gamma-ray intensities, the corrections for the angular dependence of the photoelectric process were applied according to the method of Hultberg. A total of 31 transitions was detected. Twelve new gamma rays of energies 156.12, 220.11, 444.20, 480.00, 497.30, 516.92, 607.24, 652.27, 664.23, 789.38, 1117.19, and 1595.30 keV were found which could all be identified as transitions from the decay of 17-hr ^{188}Re. The observed data can be consistently accounted for in terms of a decay scheme involving the following levels of ^{188}Os: 0, 155.02, 479.00, 633.13, 789.40, 1086.05, 1306.16, 1461.21, 1750.32, 1765.35, 1941.11, and 1958.44 keV. Two excited states in ^{188}Os at energies 479 and 789 keV which were not discovered before from similar studies were observed. The level at 1306.14 keV above the ground state was supported by the observation of a high-energy gamma ray at 1306.22 keV. (auth)

5550 HIGH RESOLUTION GAMMA-RAY SPECTROSCOPIC STUDIES OF ^{119}Te ISOMERS. **Berzins, G.; Kelly, W. H. (Michigan State Univ., East Lansing). Nucl. Phys., A92: 65-83(1967).**

Gamma rays emitted in the decay of 16-hr ^{119g}Te and 4.7-day ^{119m}Te were investigated with Ge(Li) detectors. Coincidence data, obtained with various Ge(Li) and NaI(Tl) detector combinations, suggest that the shorter-lived isomer populates excited states at 644.1, 699.6, 1328, 1338.7, 1412.8, 1487, 1749.1 and 1820 keV in ^{119}Sb. The decay of ^{119m}Te populates levels at 270.3, 1048.1, 1212.6, 1249, 1365.8, 1407, 2129, 2225, 2278, 2283 and 2360 keV. Tentative spin assignments are suggested from log ft values and previously reported internal conversion-electron data. (auth)

5551 NUCLEAR STRUCTURE STUDY USING MEDIUM ENERGY CHARGED PARTICLES. Ricci, R. A. (Istituto Nazionale di Fisica Nucleare, Naples. Univ., Naples). Nuovo Cimento (1), 3: Suppl., 726-58(1965). (In Italian).

The most significant results obtained in the last few years in the field of nuclear spectroscopy by Coulomb excitation, inelastic scattering, mapped-out reactions, quasi-elastic scattering, transference reactions, and (α,xn) reaction are summarized. (J.S.R.)

5552 REACTIONS INDUCED BY FAST NEUTRONS. Rubbino, A. (Univ., Catania, Italy). Nuovo Cimento (1), 3: Suppl., 688-705(1965). (In Italian).

The principal experimental results obtained in the study (n,α), (n,p), (n,2n) reactions are summarized. Reactions of the (n,n) and (n,d) types are also briefly discussed. Analysis of the experimental results indicates that the predictions of the statistical model are satisfactory with no strong divergences. The contribution of the direct interaction is also briefly considered. (J.S.R.)

5553 ON THE LOW-LYING ENERGY-LEVEL SCHEME OF ^{179}Hf. **Manfrass, P.; Andreeff, A.; Bergmann, W.; Kaestner, R. (Zentralinstitut fuer Kernforschung, Dresden). Nucl. Phys., A92: 123-32(1967). (In German).**

The spectrum of the low-energy gamma rays of ^{179}Hf produced in neutron capture was measured with a scintillation coincidence spectrometer and a Ge(Li) detector. From the measurements it was concluded that the level at 522.5-keV excitation energy is the Nilsson level with quantum numbers $^{3}/_{2}^{-}$ [512]. The levels at 587.2, 679.2 and 801.5 keV excitation energy are the $^{5}/_{2}^{-}$, $^{7}/_{2}^{-}$ and $^{9}/_{2}^{-}$ levels of the $^{3}/_{2}^{-}$ [512] rotational band. (auth)

5554 THE ^{118}Sn(p,2p)^{117}In EXCITATION FUNCTION AND ISOMERIC RATIO AT HIGH ENERGIES. **Caretto, A. A. Jr. (European Organization for Nuclear Research, Geneva. Carnegie Inst. of Tech., Pittsburgh). Nucl. Phys., A92: 133-8(1967).**

The excitation function of the ^{118}Sn(p,2p)^{117}In reaction and the isomeric ratio of ^{117}In produced by this reaction were determined at energies of 220, 421 and 590 MeV and 18 GeV. The magnitude and energy dependence of the cross sections are in good agreement with similar studies on other target nuclei in this energy region. The experimental isomeric ratio compares favorably with predictions based on a simple (p,2p) knock-out mechanism. (auth)

5555 PAIRING VIBRATION AND PARTICLE-HOLE STATES EXCITED IN THE REACTION ^{206}Pb(t,p)^{208}Pb. **Broglia, R. A.; Riedel, C. (Niels Bohr Inst., Copenhagen). Nucl. Phys., A92: 145-74(1967).**

The experimental data of the ^{206}Pb(t,p)^{208}Pb reaction are analyzed. The ground state of the initial and final nucleus as well as the first excited 0^{+} state in ^{208}Pb are described by means of the pairing model. For the odd-parity levels, eigenfunctions calculated with realistic and δ residual forces are used. Special attention is paid to the selectivity of the two-body stripping reaction and to the collective particle-hole states. The dependence of the angular distributions on the nuclear structure and on the approximations made in calculating the reaction is studied. (auth)

5556 YIELDS OF MOLYBDENUM ISOTOPES IN THE FISSION OF ^{232}Th AND ^{238}U BY 14.8-MeV NEUTRONS. Ganapathy, R.; Ihochi, H. (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 28: 3071-3(Dec. 1966). (COO-3235-3).

Samples of ^{232}Th and ^{238}U were irradiated with 14.8-MeV neutrons produced by the T(d,n)^{4}He reaction. Molybdenum was separated from the fission products using standard radiochemical procedure. Beta counting of the samples was begun 30 to 35 min after the end of irradiation and was continued every minute for about 2 hr. The counting was continued until the slope of the 66-hr ^{99}Mo was established. All samples were counted through a 15 mg/cm^{2} aluminum absorber to discriminate against the 6.0-hr ^{99m}Tc conversion electrons. After subtraction of 66-hr ^{99}Mo from the gross β activity, the tail part of the resultant curve resembled the growth-decay curve of the 14.6-min ^{101}Mo – 14-min ^{101}Tc combination. A theoretical curve for the total activity of this pair, computed using the calculated efficiencies, was fitted to the tail part of the observed curve after subtracting the contribution due to ^{99}Mo. The 11-min decay of ^{102}Mo – ^{102}Tc was obtained on subtraction of this theoretical curve from the observed points (less ^{99}Mo). The slope of the last decay curve was found in every case to be 11.0 ± 0.5 min for ^{102}Mo. (S.F.L.)

5557 THORON HALF-LIFE. Hursh, J. B. (Univ. of Rochester, N. Y.). J. Inorg. Nucl. Chem., 28: 2771-6(Dec. 1966).

The half lives of ^{220}Ra and ^{219}Ra were redetermined using a detector which depends upon charcoal-particle adsorption of the gas and measurement of the α particles by a scintillation screen with photomultiplier techniques. The value obtained for the ^{220}Ra half life is 55.61 ± 0.04 sec, and the value obtained for ^{219}Ra is 3.96 ± 0.01 sec. (auth)

5558 EVALUATION OF CROSS SECTIONS AND RESONANCE PARAMETERS FOR ^{235}U, ^{233}U, ^{239}Pu, AND ^{241}Pu BETWEEN Cd-CUTOFF AND 10 keV. **Hennies, H. H. (INTERATOM, Bensberg, Ger.). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/5, 46p. (CONF-661014-21). DTIE.**

From IAEA Conference on Nuclear Data, Paris.

Fission and capture cross sections between Cd-cutoff and 10 keV have been evaluated for the fissile isotopes, based on the available experimental differential cross sections, capture-to-fission ratios, and total fission and capture resonance integrals. In particular, the recommended cross-sections contained in the 1965 edition of BNL-325 were compared with some other evaluations and with more recent results of cross-section measurements using nuclear explosives in space and underground. As a result of this evaluation, it was found that even for the most intensively studied nucleus, ^{235}U, the uncertainties in the fission cross-section σ_f are about ±5% and in the capture cross section σ_c, ±20%. For ^{239}Pu, σ_f is known to ±10% and σ_c to ±25%. For ^{233}U and ^{241}Pu, the uncertainty in σ_f is ±20% and in σ_c ±30%. Different sets of resonance parameters for the resolved resonances, which are recommended in BNL-325 or by other research laboratories, were compared by calculating infinitely dilute total and partial resonance integrals. Calculations were performed with the resonance integral code TRIX-1 which was developed at Atomics International and is based on the single-level Breit Wigner model. The well-known limitations of this model for nuclei, such as the fissile nuclei, with narrowly spaced interfering levels, results in calculated fission resonance integrals which are 10 to 20% too small when compared with integrated measured differential cross sections. This result was found for energy regions where the cross sections are sufficiently well-known to make such a comparison possible. Average parameters for the unresolved resonances have been extrapolated from resolved resonance parameters. Calculated partial resonance integrals, using these parameters, were compared with integrated measured cross sections where these are available. As no published capture cross-section measurements exist in the resonance region for ^{233}U, ^{239}Pu, and ^{241}Pu these cross-sections were calculated with the determined average parameters and appropriate statistical distributions. (auth)

Nuclear Theory

Refer also to abstracts 5374, 5469, 5489, 5499, 5504, 5506, 5525, and 5552.

5559 (AD-641192) PHENOMENOLOGICAL AND MICROSCOPIC ANALYSIS OF PROPERTIES OF EVEN-EVEN NUCLEI. PART C. MICROSCOPIC MODELS. **Heras, C. A.; Abecasis, S. M.; Bosch, H. E. (Instituto de Investigactione Aeronautica y Espacial, Buenos Aires (Argentina)). Mar. 1966. 241p. CFSTI $3.00 cy, $0.65 mn.**

A survey of the microscopic description of the properties of even-even nuclei is presented. 357 references. (D.C.W.)

5560 (ANU-P-351) AN INTRODUCTION TO SCATTERING THEORY AND DIRECT REACTIONS. A Series of Lectures. Robson, B. A. (Australian National Univ., Canberra Inst. of Advanced Studies). Aug. 1965. 68p. Dep. mn.

An outline of scattering theory and the theory of direct reactions is presented. (D.C.W.)

5561 (EUR-3074.e) ON A STOCHASTIC PROBLEM IN NON-LINEAR SYSTEMS WITH A REFERENCE TO CORRELATIONS IN NUCLEAR REACTOR THEORY. Larisse, J. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 20p. Dep. mn.

A stochastic non-linear system, a particular case of which is a nuclear reactor, is described. A functional equation is derived between the statistical properties of the input, the output, and the characteristic function of the unit impulse response, from which it is possible to obtain a general method of calculation of correlations. (auth)

5562 (JINR-E4-2934) EQUILIBRIUM DEFORMATIONS OF HEAVY NUCLEI CALCULATED WITH PROJECTED WAVE FUNCTIONS. **Sobichevski, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 21p. Dep. mn.**

The ground-state equilibrium deformations, electric quadrupole moments, and deformation energies are calculated for even nuclei in the heavy element region. Projected wave functions (PBCS) corresponding to a definite number of particles are used. It is found that the main effect of using the PBCS wave functions instead of the BCS ones appears at the beginning of the region and consists in the earlier appearance of the deformation and in the large values of it. (auth)

5563 (JINR-E4-2940) DEPENDENCE OF THE GROUND STATE ENERGY AND QUADRUPOLE MOMENT ON DEFORMATION FOR HEAVY NUCLEI. **Kukhtina, I. N.; Sobiczewski, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 22p. Dep. mn.**

The ground-state energies and the ground-state quadrupole moments are calculated as functions of the deformation for even nuclei in the heavy element region. The projected wave functions corresponding to a definite number of particles are used. The results obtained with the wave functions obtained by Bardeen, et al. [Phys. Rev. 108: 1175(1957)] and in the independent-particle approximation are also presented for completeness. (auth)

5564 (JINR-P2-2974) DISPERSIONNOE PRAVILO SUMM DLYA MAGNITNYKH MOMENTOV I SPINOVAYA ZAVISIMOST SECHENII FOTOPOGLOSHCHENIYA. **(Dispersion Sum Rule for Magnetic Moments and Spin Dependence of Photoabsorption Cross Sections). Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 13p. (In Russian). Dep. mn.**

The spin dependence of the cross sections of the photon absorption by nucleons and the nuclei is discussed on the basis of the dispersion sum rule for the magnetic moments. The estimates obtained show that the spin effect in the photon and nucleon interaction with an energy more than 1 GeV is considered. It is shown with the help of the sum rule that in the Fermi-gas model the anomalous magnetic moment of the bound nucleon increases by 4 to 6% in comparison with the free nucleon. (auth)

5565 0^+ LEVELS IN A = 4n SELF-CONJUGATE NUCLEI. Bartis, F. J. (Indiana Univ., Bloomington). Nuovo Cimento (10), 45B: 114-18(Oct. 11, 1966).

A simple model is proposed for spherical A = 4n self-conjugate nuclei. Its important feature is a symmetric four-nucleon correlation in angular momentum space. This correlation prevails in a series of 0^+ rotational levels whose spacing can be found from the nuclear radius. Excitation energies of 5.99 and 3.36 MeV are calculated for the low-lying 0^+ levels of ^{16}O and ^{40}Ca, respectively, in excellent accord with experiment. In ^{4}He a previously unreported 0^+ level is predicted at (14.8 ± 1.9) MeV. (auth)

5566 HINDRANCE OF ALLOWED BETA TRANSITIONS OF GT TYPE TO THE ONE-PHONON STATE IN EVEN-MASS NUCLEI. **Futami, Yasuhiko (Tokyo Univ.); Sakai, Mitsuo. Nucl. Phys., A92: 91-6(1967).**

The relative transition probability for beta decay of 1^+ states in odd-mass nucleides to the first even-mass 2^+ state with respect to the ground-state transition was calculated in the framework of the microscopic description. The calculation was performed in the following three regions: Ga−Sr ($p_{3/2}-p_{1/2}$), Rh−In ($g_{9/2}-g_{7/2}$) and Sb−Nd ($d_{5/2}-d_{3/2}$). It was found that the well-known retardation phenomenon of the transition to the phonon state can be explained fairly well with this model. (auth)

5567 ELASTIC AND INELASTIC NUCLEAR SCATTERING OF HEAVY IONS. **Potgieter, J. M.; Frahn, W. E. (Univ. of Cape Town). Nucl. Phys., A92: 84-90(1967).**

The differential cross sections for elastic and inelastic scattering of heavy ions are described in closed form. The expressions for inelastic scattering include single, double, and mutual excitation of the reaction partners. Experimental data for ^{16}O + ^{12}C at 168 MeV, for ^{12}C + ^{12}C at 127 MeV, and for ^{12}C + ^{208}Pb at 125.6 MeV are analyzed. The formalism is extended to account for particle identity in the initial and/or final states of the ^{12}C + ^{12}C system. (auth)

5568 APPLICATION OF THE SUPERFLUIDITY MODEL FOR THE INVESTIGATION OF NON-AXIAL NUCLEI. **Shaker, M. O.; Kresnin, A. A. (Atomic Energy Establishment, Cairo). Nucl. Phys., A92: 57-64(1967).**

A method for calculating the non-axial moments of inertia within the framework of the superfluidity model is developed. As an example, calculations for ^{182}W are performed in detail. The calculated energies of rotational states are in good agreement with the experimentally observed ones. (auth)

5569 HIGHER-ORDER CORRECTIONS TO THE Λ BINDING ENERGY IN NUCLEAR MATTER. Ranft, G. (CERN, Geneva). Nuovo Cimento (10), 45B: 138-52(Oct. 11, 1966).

The convergence of the usual expansion for the well depth D of a Λ particle in nuclear matter is examined for a pion-exchange potential and a square-well potential. Terms of second order in the Λ-nucleon potential tail are found to give important contributions to D. (auth)

5570 CHANNEL EQUATIONS FOR REARRANGEMENT COLLISIONS. **Rimini, A.; Weber, T. (Univ., Trieste, Italy). Nuovo Cimento (10), 45B: 190-205(Oct. 11, 1966).**

By making use of biorthogonal systems of vectors, a system of equations is derived for the wave functions pertaining to a group of reaction channels not all belonging to the same partition of the particles. The linear independence of channel manifolds, which is required in order that the procedure be applicable, is discussed in several cases of interest. (auth)

5571 COLLECTIVE VIBRATIONS IN EVEN-EVEN SPHERICAL NUCLEI WITH NEUTRON-PROTON PAIRING INTERACTION. Brandus, I.; Dumitrescu, O.; Sandulescu, A. **(Univ. of Helsinki). Nuovo Cimento (10), 45B: 259-64(Oct. 11, 1966).**

A generalized canonical transformation is applied to a Hamiltonian containing the pairing of both kinds of nucleons in all of the T = 1 states and, in addition, a long-range part in the form of a multipole-multipole interaction. The quasi-particle Hamiltonian obtained is then used to obtain the system of equations determining the amplitudes of the collective phonon states. The case of the one-phonon states is studied in the quasi-boson approximation, and expressions for the excitation energy and the wave functions are derived. (D.C.W.)

5572 ANGULAR MOMENTUM EFFECTS IN NUCLEAR EVAPORATION PROCESSES: CHARGED-PARTICLE EMISSION. **Williams, David C. (Los Alamos Scientific Lab., N. Mex. Princeton Univ., N. J.); Thomas, T. Darrah. Nucl. Phys., A92: 1-29(1967). (LA-DC-8150).**

The effect of angular momentum upon the evaporation of neutrons, protons, and alpha particles from excited nuclei was calculated from the statistical model. The level density assumed was of the Fermi gas type with a Gaussian J-dependence of values of J corresponding to a classical rotation energy less than the total excitation energy; it was assumed that there were no levels with J-values higher than this. Transmission coefficients for the emitted particles were computed as a function of the compound-nucleus angular momentum included the average energy of the first emitted particle, the average change in angular momentum, the particle emission widths, and the ratios of emission widths. The effect of angular momentum upon these quantities can be quite different for different nuclei at different excitation energies and for different choices of the parameters, especially the nuclear moment of inertia. When the classical rotational energy is considerably less than the excitation energy, these variations can be readily understood with the aid of approximate formulas derived from a very simple model. These formulas also give a rough guide as to the order of magnitude of the effects to be expected in any particular case. The results can be greatly altered when the compound-nucleus spin is greater than the angular momentum of any available levels in the residual nucleus. Particle emission widths are sharply reduced, sometimes drastically, and the effect can be quite different for different particles, thus altering their emission ratios. Gamma de-excitation, which is not considered, will be important in some such cases. (auth)

5573 DISTORTED WAVE APPROXIMATION IN THE THEORY OF DIRECT REACTIONS. Agodi, A. (Univ., Catania, Italy). Nuovo Cimento (1), 3: Suppl., 483-95 (1965). (In Italian).

Direct reactions are defined, and the formal theory of direct reactions is given. The distorted-wave approximation is derived and is applied to the theory of direct reactions. The results and problems of this application are considered. (J.S.R.)

5574 BINDING ENERGY OF NUCLEONS AND NUCLEAR STRUCTURE FROM (e,e'p) REACTIONS. **Cortellessa, G. (Istituto Superiore di Sanita, Rome). Nuovo Cimento (1), 3: Suppl., 820-39(1965). (In Italian).**

The present knowledge on the binding energy of nucleons in nuclei is summarized; data on the lower-lying levels are emphasized. (J.S.R.)

5575 NUCLEAR MODELS AND REACTION THEORY. Bloch, C. (CEN de Saclay, Gif-sur-Yvette, France). Nuovo Cimento (1), 3: Suppl., 887-93(1965). (In French).

A very brief review is given of the methods used for the study of nuclear structure. The extension of these methods to nuclear reactions is then developed in more detail. (J.S.R.)

5576 CHARGE ASYMMETRY OF NUCLEAR FORCES AND THE PURITY OF THE ISOBARIC SPIN. Okamoto, K. (Univ. of New South Wales, Sydney). Genshikaku Kenkyu, 10: 613-32 (Mar. 1966).

The charge asymmetry of nuclear forces is studied. The Coulomb energy difference of mirror nuclei is generally smaller than their binding energy difference by 20 to 30%. This implies the existence of charge asymmetry and that the n−n interaction is stronger than the p−p interaction. A quantitative estimate of the magnitude of charge asymmetry is made by various methods and is found to be 1 to 2%. A charge asymmetry of this order of magnitude is not inconsistent with the experimental data on the n−n scattering length. The correspondence between the levels of mirror nuclei does not necessarily exclude the existence of such charge asymmetry. The purity of the isobaric spin would not increase very seriously. On the other hand, if such charge asymmetry is assumed, a large difference of the ft values in the β decays of ^{12}B and ^{12}N could be explained without assuming G parity noninvariance, although a definite conclusion is difficult. (NSA of Japan)

5577 ENERGY DEPENDENT COMPLEX POTENTIALS AND BOUND STATES. Alberi, Giorgio; Ghirardi, Giancarlo (Univ., Trieste, Italy). Nucl. Phys., 87: 470-6(1966).

The Levinson theorem is derived for a class of rotationally invariant, energy-dependent, complex local potentials. Proper conditions are imposed on the potentials in order to make them reasonable. The obtained relation connects the real part of the scattering phase shift to the number of bound states. (auth)

5578 EXCITED STATES OF ODD DEFORMED NUCLEI. Sharipov, Sh. (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Dokl. Akad. Nauk Uz SSR, No. 4, 27-9(1966). (In Russian).

The sequence of the spins and relation of energies of excited states of odd-mass deformed nuclei, for which the ground-state spin is equal to $^5/_2$, were examined. The sequence of spins and their dependence on the parameter γ characterizing the amplitude of the 0 γ oscillation of the nuclear surface were shown graphically. The theoretical and experimental values of the spin and energy levels of ^{233}U were tabulated. Comparison of the theoretical and experimental values indicates that the sequence of spins and the energy values of ^{233}U can be satisfactorily explained within the framework of both the axial and nonaxial theory. (J.S.R.)

5579 REPRESENTATIONS OF FINITE U_3 TRANSFORMATIONS. Chacon, E.; Moshinsky, M. (Univ. Nacional de Mexico, Mexico City). Phys. Lett., 23: 567-9(Dec. 5, 1966).

The representation matrices of finite U_3 transformations are explicitly determined. (auth)

5580 THE ABSOLUTE CROSS SECTIONS OF THE (t,p) AND (^{3}He,p) REACTIONS. Mathur, V. S.; Rook, J. R. (Nuclear Physics Lab., Oxford). Nucl. Phys., A6702: 305-18 (1967).

The absolute value of the differential cross section for the ^{16}O(t,p)^{18}O (g.s.) reaction is calculated in the distorted-wave approximation using Ohmura's hard-core wave function to describe the internal motion of the nucleons in the triton. A reasonable agreement with the observed value of the cross section is obtained while reproducing at the same time the observed binding energy and the size of the triton. Further, an explanation is offered for the equality of the absolute cross sections of the (p,t) and (p,^{3}He) reactions leading to analog isobaric states, apart from factors depending on momentum and isospin transfer, in spite of a considerable difference in the rms charge radii of the triton and ^{3}He. (auth)

5581 PARITY IMPURITIES DUE TO A STATIC PNC POTENTIAL. Maqueda, E.; Blin-Stoyle, R. J. (Univ. of Sussex, Brighton, Eng.). Nucl. Phys., A6702: 460-4(1967).

It is shown that unlike the $\sigma \cdot p$ single-particle, velocity-dependent potential, a static parity nonconserving (PNC) potential can lead to both electric as well as magnetic irregular transitions even for a spin-independent nuclear Hamiltonian. Specific calculations are made of the circular polarization P to be expected in the case of the 480 keV γ-transition in ^{181}Ta due to a static PNC potential. It is found that $P \approx 0.7 \cdot 10^{-4}$. (auth)

5582 LATEST ACHIEVEMENTS WITH EXCITED NUCLEAR CORE MODELS. De-Shalit, A. (Weizmann Inst. of Science, Rehovoth, Israel). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 198-203 (Feb. 1966). (In Russian).

The excited-core nuclear model, based on the concept of the excitation of the whole core, was developed to describe excited-core states, in order to be able to identify them in nuclear spectra. In some respects, it may be considered a generalization of the shell model but it differs from the concept originally proposed by R. D. Lawson, and I. L. Utresky and from the weak interaction calculations of L. Silverberg. In the new variant, it is not assumed that the state of the core coincides with the state of an even-even nucleus, although an analysis of the experimental data indicates that the core of odd nuclei possesses intermediate properties with respect to the neighboring even-even nuclei. Identification of certain states as excited ones may be helpful to localize one-particle levels and to study the lower excitation states of even-even cores. Multiplets of the excitation of the core may reveal certain laws observed in even-even nuclei; the odd isotopes of Tl were examined from this point of view. The odd Au isotopes reflect the quadruplets of the excited states; this may be explained by making use of the excited-core model. Analysis of the odd isotopes of Tl, Hg, and Au reveal the importance of the dipole-dipole component of the interaction between the core and a particle. More exact measurements are needed to subject the model to a rigorous verification. (TTT)

5583 DIFFRACTION PHENOMENA IN NUCLEAR REACTIONS. De-Shalit, A. (Weizmann Inst. of Science, Rehovoth, Israel). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 204-8(Feb. 1966). (In Russian).

It was observed some time ago that the differential cross section is only slightly dependent on the energy or mass of the target nucleus. It was therefore attempted to clarify the correlation between the reaction cross section and the properties of the bombarding nuclei. J. S. Blair, S. I. Drozhdov, and E. V. Inopin were the first ones to attract attention to such a "differential" model, which is able to explain in some cases the reasons for the observed differential cross section and polarization. Calculation of these properties by this model is based on a relatively simple closed system of equations. Of special importance for the calculations is the radius of the barrier which has an order of magnitude of 1.5 $A^{1/3}$ fermi. The other specific property of diffraction phenomena related to the concept of the radius, is the mean "absorption capacity." At its present state of development, the theory is able to explain collision phenomena, especially when it relates to a high probability of the breaking-up or excitation of particles, including total absorption; the latter term designates any process leading to the decrease of the intensity of an elastically scattered beam. The probability of transfer reactions decreases rapidly with the increasing distance between the colliding particles. More recently, attempts were made to explain the polarization on the basis of the diffraction model; although only the elastic scattering phenomena were studied, the results indicate that the model may be applied more generally. (TTT)

5584 REACTION MATRIX ELEMENTS FOR SHELL-MODEL STUDIES OF NUCLEAR SPECTRA. Wong, Chun Wa (Princeton Univ., N. J.); Wong, Cheuk-yin. Contract AT(30-1)-937. Nucl. Phys., A6702: 433-8(1967). (PUC-937-214).

Two aspects of the evaluation of reaction matrix elements for shell-model studies of nuclear spectra are considered. It is shown that the use of Blatt-Jackson low-energy potentials has approximate validity in studies of nuclear spectra. For a range of nuclei, estimates are made of the parameters of harmonic-oscillator single-particle wave functions to be used in the calculation of reaction matrix elements. (auth)

5585 APPLICATION OF THE REACTION MATRIX THEORY. I. THE CALCULATION OF NUCLEAR REACTION MATRIX ELEMENTS. Wong, Chun Wa (Princeton Univ., N. J.). Contract AT(30-1)-937. Nucl. Phys., A6702: 399-432(1967). (PUC-937-215).

The reference-spectrum expansion of Bethe, Brandow, and Petschek is used to express the nuclear reaction matrix as a perturbation series in terms of a state-independent reference matrix. A simple treatment of the projection (or Pauli) operator in the intermediate-state sum is obtained, in the harmonic-oscillator representation of shell-model states by making certain well-defined averages. The same operator is also examined from the point of view that they are made up of localized operators of the nuclear-matter type corresponding to local effective densities which are position-dependent. These two distinct points of view, called respectively global and local, are investigated numerically in the ${}^1S_0$, ${}^3S_1$ and other states for the Hamada-Johnston potential in an A = 18 nucleus. It is found that the simple local-density approximation for treating the Pauli operator gives results very close to the global treatment, which is considered exact here. In particular, the local approximation re-produces the global results if the position-dependent effective density is allowed to extend, by some 0.9 fm, beyond the local density at the half-density point. By using state-dependent average effective Fermi momenta based on such density distributions, it is shown that the calculation of nuclear reaction matrix elements is now made as simple (and probably as accurate) as that for nuclear matter. The reliable calculation methods thus obtained make it possible to examine the properties of these matrix elements. It is found that the local interactions (in local treatments) are enhanced in the nuclear surface region and that the reduced matrix elements are particularly sensitive to the single-particle energies of the initial state. The $^3S_1$ matrix elements are shown to decrease rapidly in strength as the amount of tensor force in the nucleon-nucleon potential increases. The importance of using correct single-particle wave functions is emphasized by showing that in light nuclei improvement of the simple harmonic-oscillator shell model leads to drastic corrections. (auth)

5586 DEUTERON–NUCLEUS OPTICAL POTENTIAL. Hodgson, P. E. (Nuclear Physics Lab., Oxford). Advances Phys., 15: 329-416(July 1966).

The available knowledge of the deuteron optical potential is summarized, and the extent to which it is able to account for nuclear interactions involving deuterons is indicated. The main emphasis is on the analyses of experimental data on deuteron elastic scattering, and the relevant theories are summarized comparatively. (J.H.M.)

5587 FINE STRUCTURE OF A DOORWAY STATE. Mahaux, C.; Weidenmueller, H. A. (Univ., Heidelberg). Nucl. Phys., A6702: 241-61(1967).

The distributions of the poles and residues of the S-matrix are investigated in a single-channel case, when a doorway-state mechanism is operative. Three cases are studied: $\Gamma\uparrow \gg \Gamma\downarrow$, $\Gamma\uparrow \approx \Gamma\downarrow$, $\Gamma\uparrow \ll \Gamma\downarrow$, where $\Gamma\uparrow$ and $\Gamma\downarrow$ denote the decay width and spreading width of the doorway state, respectively. While the energy-averaged cross section is always characterized by a simple Lorentzian, this generally does not apply to the above-mentioned distributions. The full width at half-maximum of these distributions can be much smaller than the sum $\Gamma\uparrow + \Gamma\downarrow$. An analysis of the experimentally observed fine structure in terms of a pole expansion of the K-matrix appears to be a convenient tool for a test of the doorway-state hypothesis. (auth)

5588 EXACT DETERMINATION OF GAMOW–TELLER MATRIX ELEMENTS FOR SUPERMULTIPLET STATES. Kushner, M.; Quintanilla, J. (Univ., Mexico, Mexico City). Phys. Lett., 23: 572-3(Dec. 5, 1966).

The allowed Gamow–Teller beta decay matrix elements for supermultiplet states are derived exactly using the representations of the generators of the U_4 group. The transition between the ground states of ^{18}F and ^{18}O is evaluated explicitly. (auth)

5589 THE FORM OF THE PARITY-MIXED $\gamma-\gamma$ ANGULAR CORRELATION FUNCTION. Rasera, R. L. (Univ., Bonn). Phys. Lett., 23: 569-71(Dec. 5, 1966).

The directional correlation function for cascades involving parity-mixed gamma transitions is shown to split into two independent terms, according to parity. As a result, in this case angular correlation measurements are sensitive to parity admixtures. (auth)

5590 NEW ALPHA-DECAY BARRIER PENETRABILITIES WITH IGO POTENTIAL: ODD-MASS NUCLEI. Kohlmann, L.; Voros, T. (Hungarian Academy of Sciences, Budapest). Can. J. Phys., 44: 3047-51(Dec. 1966).

Barrier penetrabilities, reduced widths, and hindrance factors are given for odd-mass alpha-particle emitters measured after 1959. The method of calculation is as in a previous publication. The calculated quantities are given for the total decay energy. (auth)

5591 RELATION BETWEEN TOTAL AND PARTIAL WIDTHS IN NUCLEAR REACTIONS. Humblet, J. (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Liege); Lejeune, A. Phys. Lett., 23: 561-4(Dec. 5, 1966).

The ratio between the total width and the sum of the partial widths as defined in the S-matrix theory was calculated for two resonance levels of ^7Be from a simultaneous fitting of the reactions $^6Li(p,p)$, $^3He(\alpha,\alpha)$, and $^6Li(p,\alpha)$. (auth)

5592 APPLICATIONS OF THE NON-DEGENERATE STATISTICAL RELATION TO BINDING ENERGY CHARACTERISTICS IN NUCLEI. Dutta, A. K. (Univ. Coll. of Science, Calcutta). Indian J. Phys., 40: 362-4(June 1966).

A set of statistical relations is presented with which the optimum binding energy of a nucleus, the equivalent uniform radii of nuclei, and the optimum proton number in a nucleus can be calculated. Numerical results for some of the most strongly bound nuclei are presented and are compared with experimental results. (D.C.W.)

5593 MATERIALY XV EZHEGODNOGO SOVESHCHANIYA PO YADERNOI SPEKTROSKOPII I STRUKTURE ATOMNOGO YADRA, MINSK, 25 YANVARYA–2 FEVRALYA 1965. (Reports of the 15th Early Conference on Nuclear Spectroscopy and Nuclear Structure, Minsk, Jan. 25–Feb. 2, 1965). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 194-384(Feb. 1966). (CONF–650119(Vol.4)).

Papers presented at the conference include theoretical studies on various nuclear models, such as the excited core model and the differential model. The lifetime of the 22.5-keV first excited state of ^{149}Sm was determined by the scintillation spectroscopic method. Delayed transitions in ^{186}Re and ^{188}Re, arising from (n,γ) reactions were investigated in the horizontal beam hole of the VVR-M reactor of the A. F. Ioffe Institute. A scintillation γ spectrometer was used to study the decay scheme of ^{240}Am. The nuclear reactions reported included an investigation of the sensitivity of the $^{11}B(p,\gamma_1)^{12*}C$ and $^{11}B(p_1,\alpha_0)^8Be$ reactions toward proton polarization near the 162-keV resonance, and the $^{12}C(d,p)^{13}C$ reaction at low deuteron energies. The reported experimental techniques included charged-particle spectrum measurements at small angles and scintillometric studies with an instrument possessing discrimination with respect to charged particles. The study of inelastic scattering of electrons on ^9Be served as the basis for reviewing various nuclear models. Calculation of spin-dependent effects in quasi-elastic knock-out processes was also reported. The dispersion theory of magnetic dipole spallation of deuterons was examined under consideration of internucleon interaction on the basis of the Yamaguchi potential. (TTT)

5594 NUCLEAR SPIN COOLING METHOD. Jeffries, Carson D. (to U. S. Atomic Energy Commission). U. S. Patent 3,281,661. Oct. 25, 1966. Filed Nov. 18, 1963.

A method is described for cooling or polarizing the nuclear spins in a hydrated crystal containing a small amount of paramagnetic ions. Such a polarized crystal is useful as a target for nuclear scattering as well as in masers and lasers. In the method described, a crystal to be polarized is maintained at a sink temperature slightly greater than 0°K and in a magnetic field. The electron spin system is alternately coupled to the crystal lattice and to the nuclear spin system by varying the angular orientation of the crystal with respect to the magnetic field, thereby changing the relative values of the electron spin g-factor with respect to nuclear spin g-factor. (AEC)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 4433 and 4914.

5595 (AECL-2486) THE ELEVENTH AECL SYMPOSIUM ON ATOMIC POWER HELD AT TORONTO, ONTARIO, OCTOBER 13-14, 1966. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). 136p. (CONF-661026). Dep. mn. AECL $2.00.

The status of nuclear power in Canada is examined with major emphasis on nuclear power stations operating or under construction. Papers are presented on the status of Douglas Point, Rajasthan, Karachi, Gentilly, Pickering, and NPD atomic power projects, and the uses of radiation and radioisotopes in Canadian industry are discussed. (H.D.R.)

5596 (ANL-7001) 1000-MW(e) METAL-FUELED FAST BREEDER REACTOR. Link, L. E.; Ayer, J. E.; Butler, D. K.; Hub, K. A.; Loewenstein, W. B.; Mecham, W. J.; Meneghetti, D.; Thompson, D. H.; Trice, V. G. Jr.; Weills, J. T. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 125p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

A design study of a metal-fueled fast power breeder reactor was made to explore the burnup limits using a model with fuel elements that have sufficient void volume for expansion of gaseous fission products. A discharge burnup of 6% appears to be a reasonable limit, according to the model, for a somewhat degraded neutron spectrum with significant Doppler broadening and a breeding ratio of about 1.5. The expansion volume is suitable for including larger fractions of Ti or Zr in the fuel to take advantage of greater high-temperature strength of such fuel for possibly higher burnup with little adverse effect on neutronic performance. The fuel-cycle results for a combined processing-fabrication plant located for simple shipment of low-decontamination fuel to three power plants, each of 1000-MW(e) capacity, are: an electric energy cost of somewhat under one mill per kW-hr; and a geometric doubling time for fissile Pu of 7.6 years. (auth)

5597 (ANL-7044) CRITICAL STUDIES FOR THE FRENCH FAST REACTOR "RAPSODIE" (ZPR-3 ASSEMBLY 44). Hess, A. L.; Keeney, W. P.; Caumette, P.; Boyer, J. P. (Argonne National Lab., Idaho Falls, Idaho). Mar. 1966. Contract W-31-109-38. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Criticality studies were carried out on ZPR-3 with a mockup of the French fast reactor, RAPSODIE. Critical data pertinent to the fuel specification for RAPSODIE, the evaluation of the RAPSODIE design control systems, and the collection of other data useful in verifying calculational techniques were acquired. The RAPSODIE core simulated in the mockup was approximately a 40-liter cylinder. The experiments included a physics-core and an engineering-core study. For the physics-core study, a simple core-blanket arrangement was constructed, and spectral indices and local reactivity coefficients were measured. In the fuel for the physics-core mockup, the ratio of U to Pu was about 5 : 1. In the fuel for the engineering core, the U-to-Pu ratio was reduced to 3.2 : 1. Mockups of the RAPSODIE axial regions, steel-Na end gaps, and different axial blankets were constructed with the engineering core, along with mockups of the RAPSODIE control and safety rods. Experiments in the full engineering mockup included rod-worth studies, material-reactivity-coefficient measurements, and traverses of neutron detectors and fuel-reactivity samples. This was the first ZPR-3 critical assembly to contain a significant loading of Pu. Heat generation from alpha decay of the Pu affected the accuracy of reactivity measurements, and the neutron source from spontaneous fission required different techniques for measuring reactor periods. (auth)

5598 (ANL-7125, pp 150-99) REACTOR SAFETY. Baker, L. Jr.; Tevebaugh, A. D.; Bingle, J. D. (Argonne National Lab., Ill.).

Studies relating to the safety of fast reactors and of metal–water reactions are reported. The chemical reactions are being studied so that realistic estimates can be made of the rates and extents of reactions during hypothetical reactor accidents. Methods used to study the reactions included isothermal reaction rate determinations, nonisothermal studies of the reactions with fine metal particles, in-pile meltdown experiments with specimens of typical reactor fuel materials, and heat experiments designed to simulate the conditions experienced by fuel elements during a loss-of-coolant accident. For reactor safety, a survey study was made of chemical and physical interactions of fuel and cladding materials at high temperature with molten sodium. Emphasis was given to detecting and evaluating exothermic alloying reactions and interactions that result in extensive break-up or frothing. (P.C.H.)

5599 (APDA-NTS-7) MEASUREMENT OF SODIUM WORTH IN THE ENRICO FERMI REACTOR. Segal, B. M.; Horne, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Sept. 1966. 40p. Dep. mn.

The reactivity worth of the Na in a core subassembly was measured as a function of the subassembly radial position in the core lattice. A specially designed type of core subassembly, in which the core section was able to be either completely voided of Na or filled normally, was used in the test. The axially averaged (or columnar) core worth of Na was obtained at seven core radii by measuring the reactivity of seven pairs of core loadings, each pair containing four of the special subassemblies in separated locations at equal radii from the core center. The special subassemblies were voided of Na in the first loading of each pair and filled for the second; four subassemblies were used together to ensure that an adequate reactivity difference would be observed between the voided and flooded loadings at each of the seven core radii studied. This reactivity difference obtained at each radius allowed the columnar core Na worth to be evaluated at that radius. The effect of bunching the four special subassemblies into adjacent rather than separated locations was investigated also. (auth)

5600 (BAW-393-8) THORIUM FUEL CYCLE FOR HEAVY WATER MODERATED ORGANIC COOLED REACTORS. Technical Progress Report No. 5, April–June 1966. (Babcock and Wilcox Co., Lynchburg, Va. Atomic Energy Div.). Aug. 1966. Contract AT(38-1)-393. 111p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work on the Heavy Water Organic Cooled Reactor (HWOCR) Th fuel cycle is described. Development of economical heavy water reactors having optimum fuel utilization is considered. The long-range objective of the Th fuel cycle development is the proof of performance of Th fuel elements in an HWOCR environment. This report period was related to the selection of a Th fuel element for future development. Fuel elements studied include Th metal nested cylinders, ThO_2 clustered pins, and ThC_2 clustered pins. An optimum design of each type was selected for final evaluation. The economics and fuel utilization of the three fuel element types were evaluated for use in a 1000 MW(e) HWOCR. Technical feasibility, development costs, and compatibility with a U-optimized HWOCR were also considered in the selection process. On the basis of technical considerations, both the oxide and metal fuel elements should be carried through several phases of irradiation testing before a final selection is made. If practical considerations require selection of one type, priority should be given to the development of the ThO_2 element. (auth)

5601 (BMI-1779) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Morrison, David L.; Genco, Joseph M.; Gieseke, James A.; Ritzman, Robert L.; Walters, Craig T.; Sunderman, Duane N. (Battelle Memorial Inst., Columbus, Ohio). Aug. 12, 1966. Contract W-7405-eng-92. 229p. (EURAEC-1735). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The complex sequence of chemical and physical processes in a loss-of-coolant accident for a nuclear power reactor was subjected to an analytical study. Data and theories on these processes were examined and employed for an analytical description of the accident. Current theories and data on critical flow and existing system blowdown models were reviewed and their limitations noted. A digital-computer code, NURLOC, was developed to perform the two-dimensional, transient-heat-transfer calculations for a given reactor system. The heat-transfer analysis included convection, conduction, radiation, fission-product-decay heating, delayed neutron heating, metal-water reactions, boil-off of residual coolant, and core slumping. Experimental data on fission-product release were examined and a model was constructed to describe the time-dependent release of fission products during an accident. A digital-computer code, FRACREL, was written for the model, with the temperature data from NURLOC used directly for input. The sensitivity of the output from FRACREL to uncertainties in the experimental data was investigated. Several transport and deposition models were applied toward the evaluation of data from experiments involving these processes. The data on transport and deposition did not provide an adequate verification of the models developed, and extrapolation of the results of experiments on these processes to reactor accidents was hampered by a lack of understanding of the fundamental mechanisms involved. Accident analyses using the models which were found applicable to describe the processes were performed for LOFT and a typical power reactor. (auth)

5602 (BNL-9563) POWER OSCILLATIONS AND THE DESCRIBING FUNCTION IN REACTORS WITH LINEAR FEEDBACK. Akcasu, A. Ziya; Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Sept. 1965. Contract AT(30-2)-Gen-16. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Periodic solutions of the kinetics equations with arbitrary linear feedback and no delayed neutrons are studied. Simple formulas are derived relating the amplitude and frequency of the limit cycles to the ratio of the equilibrium power level and critical power level. Since the techniques used apply for arbitrary values of the fundamental component of the power oscillation, they are used to derive a describing function which is valid for large amplitude disturbances. Conditions for the existence of critical power levels and limit cycles are discussed. Formulas for investigating the stability of these limit cycles are also derived. Applications are made to the circulating-fuel reactor and to the two-temperature reactor. (auth)

5603 (BNWL-305) PHYSICS SURVEY CALCULATIONS FOR A PuO_2-UO_2 FUEL IN IDEALIZED H_2O POWER REACTORS. Liikala, R. C.; Jenquin, U. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1966. Contract AT(45-1)-1830. 24p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

Calculational results describing the physics behavior of a Pu fuel in a power reactor which is light water cooled and moderated are presented. A variety of fuel and moderator temperature conditions, as well as moderator void conditions, were selected for both pressurized and boiling light water systems. The data are presented for reactor systems which are infinite in size, however, the parameters necessary to convert the results to a finite size system are also given. (J.R.D.)

5604 (CEA-R-2793) BOUCLE DE SOUFFLAGE DE LA CENTRALE EL 4: REGULATION DU DEBIT CO_2 ETUDE ANALOGIQUE. TOME I. (Blowing Loop in the EL 4 Reactor: CO_2 Flow Control Analog Study. Volume I.). Leroy, Claude; Robin, Louis; Jacquin, Jean-Claude; Cornudet, Alain (Indatom, Paris (France); Chazal, Guy; Merle, Jean-Pierre; Guillemard, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1966. 112p. (In French). Dep. mn.

One study which contributed to the construction of the Monts d'Arrée nuclear power station EL 4 is described. The reactor is cooled by a CO_2 current provided by 3 turbo—blower groups. The priming vapor for the turbines is taken at the exit of the main CO_2-H_2O exchangers. The operation of EL 4 is based on a high degree of centralization of the controls which attributes an important role to the general regulation circuits. This general regulation includes in particular an internal blowing loop which controls the CO_2 flow. The study of the control of this CO_2 flow is made up of analog representation of the reactor's cooling circuit and of the turbo-blower unit, and first test campaign using the analog computer describing the natural behavior of the system in the absence of control. (tr-auth)

5605 (CEND-271) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF YANKEE CORE V. Valerino, Michael F.; Rosztoczy, Zoltan R.; Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). June 30, 1966. Contract AT(38-1)-428. 76p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Specific application of the ISOCHECK method to Yankee Core V is straight-forward in that no distortion of reactor geometry or serious compromises in the representation of core compositions are required. Two developmental fuel assemblies were included in the core loading of Yankee Core V. Inasmuch as these fuel assemblies constitute a very small fraction of the total core loading, their presence in the core was neglected; hence, no data were obtained on isotopic content in these two fuel assemblies. The degree of accuracy generally characteristic of the state of the art of reactor physics for water reactors should apply for the predominant remaining fuel assemblies in Yankee Core V (i.e., the recycled 4.1 wt % ^{235}U-enriched assemblies and the new 4.9 wt % ^{235}U-enriched assemblies). Accuracies of ±5% for ^{235}U depletion and of ±8% for total Pu content can be expected for normal batches of operating fuel elements in the reactor. The accuracies apply for the batch as a whole, which may consist of 20 or more fuel assemblies. The batch is the smallest unit of interest, insofar as isotopic content for fuel accounting purposes is concerned, because fuel reprocessing occurs in batch loads. (auth)

5606 (CEND-271(Suppl. 1)) INPUT CARD LISTING FOR SAMPLE FLARE PROBLEM USED IN THE SETUP OF THE ISOCHECK METHOD FOR YANKEE CORE V. Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Sept. 28, 1966. Contract AT(38-1)-428. 13p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The cards are for use with FLARE-code in determination of the heavy isotope content in the fuel for Yankee Core V at the beginning of the fuel cycle. (J.R.D.)

5607 (CEND-275) SETUP OF ISOCHECK METHOD FOR DETERMINING HEAVY-ISOTOPE CONTENT IN THE OPERATING FUEL ELEMENTS OF LA CROSSE CORE I. Valerino, Michael F.; Rosztoczy, Zoltan R.; Kern, Richard (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Aug. 10, 1966. Contract AT (38-1)-428). 83p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Specific application of the ISOCHECK method to La Crosse Core I is straightforward in that no distortion of reactor geometry or serious compromises in the representation of core compositions are required. Hence, the degree of accuracy generally characteristic of the state of the art of reactor physics for water reactors should be obtainable in the use of the method. Accuracies of ±5% for ^{235}U depletion and of ±8% for total Pu content can be expected for normal batches of operating fuel elements in the reactor. The accuracies apply for the batch as a whole, which may consist of 20 or more fuel assemblies. The batch is the smallest unit of interest, insofar as isotopic content for fuel accounting purposes is concerned, because fuel reprocessing occurs in batch loads. (auth)

5608 (CONF-661108-1) THE NUCLEAR INDUSTRY, 1966. (Division of Industrial Participation (AEC), Washington, D. C.). 183p. Dep. mn. GPO $1.00.

From Atomic Industrial Forum's Annual Conference, Pittsburgh, Pa.

Central station nuclear power plants continued to receive the most attention of all the applications of nuclear energy during 1966. Expanding radiation applications in areas such as medicine, industry and space; the decision to move ahead with the world's largest desalting plant as a nuclear-powered, dual-purpose facility; and increasing interest in commercial applications of peaceful nuclear explosives; all added to the bright promise for the nuclear industry's future. All segments of the industry should feel the impact of the expansion that lies ahead. (auth)

5609 (COO-284(Vol.1)) SMALL NUCLEAR POWER PLANTS. VOLUME ONE. DESIGN, CONSTRUCTION, AND OPERATING EXPERIENCE. Burton, S. F.; Hosler, A. G. (eds.) (Chicago Operations Office (AEC), Ill. Reactor Engineering Div.). Oct. 1966. 274p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Small power reactors are of special interest to small power utilities. The report compiles the technical and economic information existing for ten nuclear power plants of less than 100 MW(e) capacity. In general, design, construction and operating problems resulted in schedule delays, additional costs and inconveniences in each project. Common problems encountered were malfunctions of control rod drives and utilization of conventional equipment. The designs are for prototypes of larger projects or first-of-a-kind plants. (J.C.W.)

5610 (EIR-96) EINE HALBEMPIRISCHE METHODE ZUR BESTIMMUNG DER NATUERLICHEN FLUSSGLAETTUNG BEI KONTINUIERLICHEM LADEN. (A Semiempirical Method for Determination of the Natural Flux Plane in Continuous Plates). Junker, K.; Hager, H. G. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). June 1966. 20p. Dep. mn.

During reactor operation a natural flux flattening occurs through the irradiation of fuel elements. The flux form can be determined by means of numerical calculations with relatively large expenditure. A pure numerical method does not contribute very much to the physical understanding of the problem. On this basis an analytical method was proposed and paralleled to it a second analytical method (the Lie series method) was discussed. Both methods are based on a one-group calculation which is sufficiently valid for optimization. Both methods were illustrated on an infinite plate reactor and it was shown that the first method is usable only in this case. The Lie series method is also usable for other geometries. (tr-auth)

5611 (EUR-3075.e) REACTOR CELL PARAMETERS IN MULTIGROUP COLLISION PROBABILITY THEORY. Amyot, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1966. 32p. Dep. mn.

A consistent set of definitions of the reactor cell parameters is presented and discussed in the framework of the multigroup, multiregion collision probability technique. The assumptions implied in the fundamental neutron balance and, in particular, the link with more general integral transport theory, are examined in the light of the recent literature on the subject. (auth)

5612 (EURAEC-1697) GARIGLIANO NUCLEAR POWER STATION RESEARCH PROGRAM. Quarterly Report No. 9.

(Ente Nazionale per l'Energia Elettrica, Rome (Italy)). July 1, 1966. Contract 101-63-11-RD I. 23p. (EUR-2884). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

During research tests, the computer was run under varied conditions showing flexibility, accuracy and reliability in forecasting and programming plant operating conditions. The control rod oscillation mechanism operated satisfactorily during stability tests. The stability test data will be checked to see if the stability calculation model is accurate for other reactors. Thermal and hydraulic data registered in the plant under various test conditions will be compiled. (J.C.W.)

5613 (EURAEC-1698) STABILITY EXPERIMENTS FOR BOILING WATER REACTORS. Quarterly Report No. 6, April 1–June 30, 1966. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergieanlagen). Contract 085-66-1TEED. 19p. (EUR-2885). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Measurements of heat output-local steam bubble content frequency responses were carried out in a cylindrical section and the scheduled measurement program was completed. The dependence of local steam bubble content on steam content and water inlet velocity is being ascertained for use in establishing measured changes in time in the local steam bubble content as a reference magnitude. Theoretical analysis of frequency responses obtained in experiments began with the help of the AMOK-L computer program. Initial comparisons between theory and the experiment have been established. (tr-auth)

5614 (GA-7276) FUEL CYCLE CHARACTERISTICS OF THE HIGH TEMPERATURE GAS-COOLED REACTOR. Stewart, H. B.; Jaye, S.; Lee, D. H. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 20, 1966. Contract AT(04-3)-167. 18p. (CONF-660926-2). Dep. mn. CFSTI $1.00 cy, $0.50 mn.

From International Nuclear Industry Fair and Technical Meetings, Basel, Switzerland.

The rapid growth of nuclear power will have a significant effect on the various cost parameters which in turn determine the fuel cycle cost. The projected U requirements for various reactor types are discussed, and possible variations in the future cost of U are indicated. The influence of U ore costs on different reactor types is shown. The fuel cycle costs for the HTGR are discussed for two sets of economic parameters. The flexibility of the fuel management programs available to the HTGR is discussed, and the possible modifications to the fuel management program to accommodate changing economic conditions are indicated. (auth)

5615 (GEAP-4973) EPITHERMAL CAPTURE AND FISSION DISTRIBUTION IN A FUEL ROD: THE COMPUTER CODE REAX. Protsik, R. (General Electric Co., San Jose, Calif. Advanced Products Operation). Apr. 1966. Contract AT(04-3)-540. 67p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

The computer code REAX was written to provide a means of analyzing the effectiveness of thermal flux filters in reducing the power depression in a highly enriched fuel pin. An extension of the computer code DOPIE, REAX calculates, as a function of radius and energy, the epithermal capture and fission events and cross sections in a homogeneous, uniform temperature fuel rod, immersed in a homogeneous medium. Radial power distributions calculated for both filtered and unfiltered, U and mixed-oxide fuel pins, to be test irradiated in TREAT are presented. (auth)

5616 (GEAP-5207) TWO-PHASE FLOW AND HEAT TRANSFER IN MULTIROD GEOMETRIES. Seventh Quarterly Progress Report, April 26, 1966–July 25, 1966. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Aug. 1966. Contract AT(04-3)-189. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Five test conditions with two-phase flow of air and water at 95 psia have been studied experimentally in the nine-rod apparatus. Qualities between 0.115 and 0.40 with mass velocities between 0.12×10^6 and 0.33×10^6 lb/h-ft^2 were investigated. Pressure drop (manometers), average void fraction (quick-closing valves), detailed local phase and void profiles (isokinetic probe), and liquid film flow rates (perforated rod wall) were measured. A flow condition and data summary and a detailed description of data for one test condition (quality of 16%) are included. Further investigation on the use of the Preston tube for indirect determination of wall shear in two-phase flow in a tube is described. The concurrent measurement of liquid film thickness has provided better understanding of the flow structure near the tube wall. (auth)

5617 (HW-60726) REAR FACE FOG SPRAY NOZZLE SPACING. Final Report (In Fulfillment of Design Test Request No. 1042). Moir, J. A. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). July 1, 1959. Contract W-31-109-eng-52. 58p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

A series of tests were conducted to select the low velocity fog spray nozzle which would most acceptably blanket a simulated reactor rear-face enclosure. To assure complete coverage, three high-velocity nozzles were evaluated in terms of their ability to throw a spray into remote rear face areas. Spray density patterns and performance data were recorded for each nozzle tested under a set of controlled conditions. The variables applied to create a test situation were water pressure, nozzle height and spacing, elapsed time, air flow, and two enclosure mockup conditions. (auth)

5618 (JINR-E4-2939) FLUX FLATTENING BY MEANS OF NON-UNIFORM FUEL DISTRIBUTION IN A SLAB REACTOR WITH FINITE REFLECTOR. Gron, M.; Lelek, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1966. 13p. Dep. mn.

Dependence of the critical size and fuel concentration on the dimension of the reflector under condition of flattened thermal flux is investigated in a slab reactor described by means of two-group equations. Space dependence of the resonance escape probability p is considered. It appears that the critical size and fuel concentration increases with the decreasing thickness of the reflector. There exists a certain minimum thickness of the reflector within which the requirement of flattened thermal flux can be fulfilled. (tr-auth)

5619 (JUL-362-RG) DAS BRUTVERHALTEN EINES EPITHERMISCHEN SALZSCHMELZENREAKTORS. I. INTERNE KUEHLUNG DURCH DIE BLANKETSCHMELZE. (The Breeding Ratio of an Epithermal Fused Salt Reactor. I. Internal Cooling by the Blanket Melt). Barthold, W. P.; Wolf, L. A.; Graf, I. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar. 1966. 47p. Dep. mn.

The breeding behavior of intermediate fast salt melt installations (MOSEL is molten salt epithermal salt reactor) with internal heat exchanger was investigated. The blanket melt was used simultaneously as coolant. The structural materials are INOR-8 or Croloy. The effect of the melt composition, Th concentration, the size of the installation, the structural materials used, and the fuel composition on the breeding ratio were determined. Modification of the breeding behavior by the selection of different effective cross section averages was investigated. (tr-auth)

5620 (JUL-380-RG) DAS BRUTVERHALTEN EINES EPITHERMISCHEN SALZSCHMELZENREAKTORS. II. INTERNE KUEHLUNG DURCH NATRIUM. (The Breeding Ratio of an Epithermal Fused Salt Reactor. II. Internal Cooling by Sodium). Barthold, W. P.; Wolf, L. A.; Graf, I. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar. 1966. 66p. Dep. mn.

The breeding behavior of intermediate fast fused salt installations (MOSEL is molten salt epithermal) was investigated. The structural material for the guide system in the core and blanket is croloy and the coolant is Na. The effect of the melt composition, the Th concentration, the size of the installation, the structural materials used, and the fuel composition on the breeding behavior was considered. (tr-auth)

5621 (NAA-SR-Memo-12163) ESTIMATES OF SIZES AND WEIGHTS OF PUMPS TO BE TESTED IN THE SPTF. Atz, R. W. (Atomics International, Canoga Park, Calif.). Sept. 20, 1966. Contract AT(11-1)-Gen-8. 17p. Dep. mn. CFSTI $1.00 cy, $0.50 mn.

The pumps to be tested in the SPTF have yet to be designed so approximations of the pumps' weights and dimensions were made to enable the conceptual design of the SPTF to proceed. Results of a survey of pumps built for large sodium systems were used as the basis for extrapolations used to estimate weights, heights, and diameters of very large pumps. Based on the estimates developed in this report a 60,000 gpm pump developing 350 feet of head at 855 rpm would be approximately 410 inches high, 151 inches in diameter, and weigh 155,000 pounds. A similar pump to deliver 120,000 gpm at 350 feet of head would be approximately 485 inches high, 177 inches in diameter, and weigh 345,000 pounds. (auth)

5622 (NUS-259) DIRECT SUBSTITUTE PLUTONIUM FUEL FOR COMMERCIAL WATER REACTORS. McLeod, N. B.; Uematsu, K.; Yasukawa, S.; Yumoto, R. (Nuclear Utility Services, Inc., Washington, D. C.). Oct. 15, 1965. 130p.

For Atomic Fuel Corp., Tokyo, Japan.

Methods of designing for the most effective use of Pu in existing and planned commercial water power reactors are described. The boiling water reactor (BWR) is used as the typical water reactor, and BWR fuel design principles and limits are considered as they might influence substitute fuel design. Specific design parameters and related economic significance are described, and it is concluded that Pu-enriched fuel can be economically substituted without significant limitation for ^{235}U fuels. (H.D.R.)

5623 (NYO-3250-5(Vol.1)) CONNECTICUT YANKEE ATOMIC POWER COMPANY: FACILITY DESCRIPTION AND SAFETY ANALYSIS. (Connecticut Yankee Atomic Power Co., Haddam). May 1966. Contract AT(30-1)-3250. 376p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Connecticut Yankee power reactor facility at Haddam, Connecticut, is described from the viewpoint of inherent and engineered safeguards to assure it can be operated with no undue hazard to the public health and safety. Volume I contains detailed descriptions of the site, containment, reactor design, reactor plant systems, and shielding. (H.D.R.)

5624 (NYO-3250-5(Vol.2)) CONNECTICUT YANKEE ATOMIC POWER COMPANY: FACILITY DESCRIPTION AND SAFETY ANALYSIS. (Connecticut Yankee Atomic Power Co., Haddam). May 1966. Contract AT(30-1)-3250. 389p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The instrumentation and control, secondary systems, electrical systems, and testing and operation procedures are described for the power reactor facility at Haddam, Connecticut. Possible incidents and the hazards from the maximum hypothetical accident are analyzed. (H.D.R.)

5625 (NYO-3370-1) CONTROL ROD DRIVE MECHANISM STUDY CONTRACT. TASK I REPORT, PHASE I. Engineering Memorandum No. 3381, Revision 1. Sherwood, Don G. (Westinghouse Electric Corp., Cheswick, Pa. Atomic Equipment Div.). Nov. 17, 1964. Contract AT(30-1)-3370. 38p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

A determination of possible actuator system improvements for PM-1 and PM-3A was accomplished by reviewing design, operating and maintenance reports of these reactors. Personnel who worked at the sites were consulted for information. The reports and interviews indicated that the main difficulties were associated with position indicating system, thimble corrosion, control rod latching and pick up, and maintenance of canned electrical equipment. Trouble in these areas has been continuous and the potential for further difficulties still exists. The remaining difficulties, although having caused plant down time, are comparatively less troublesome and have been corrected by plant personnel. (auth)

5626 (NYO-3370-2) CONTROL ROD DRIVE MECHANISM STUDY. TASK II REPORT, PHASE I. Engineering Memorandum No 3404. Sherwood, Don G. (Westinghouse Electric Corp., Cheswick, Pa. Atomic Equipment Div.). Nov. 20, 1964. Contract AT(30-1)-3370. 53p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

It is recommended that certain of the PM-1 and PM-3A control system actuator components be replaced. The major recommendations are that the position indicator system be replaced by a long differential transformer; that the rod bundle assembly be replaced by a design that assures positive control rod latching and pickup; and that the present armature section be replaced by an integral design that precludes the possibility of thimble corrosion. Alternative solutions to the major problems associated with the existing mechanism design are also discussed. (auth)

5627 (ORNL-4015) ORNL VERSION OF THEME 1 CODE: A THERMAL-HYDRAULIC CODE FOR ANALYSIS OF THE HOT CHANNEL IN A FUEL BUNDLE. Sanders, J. P. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A code developed to study the effect of the design parameters on the thermal and hydraulic conditions for axial flow with intersubchannel mixing in fuel bundles is described. The program is used to examine the conditions in hot subchannels and represents the remainder of the flow channel by its thermal and hydraulic equivalents. After specifying the major reactor characteristics, one of three options may be selected to search for acceptable values of certain parameters within the design limitations. These are the orificing factor, the channel average velocity, and the reactor temperature change. All these options may be used to select the corresponding number of total reactor flow channels. In a fourth option, the number of flow channels is specified, and the resultant thermal conditions are calculated. Mixing is represented by a mixing factor that gives the ratio of the differences in the temperature change without mixing and with mixing to the differences without mixing and with complete mixing. Thermal conditions are calculated at those points preselected by the input flux information. (auth)

5628 (ORNL-P-2532) CALCULATING FUEL CYCLE COSTS FOR LIGHT WATER REACTORS. Lane, J. A. (Oak Ridge National Lab., Tenn.). [nd]. Contract W-7405-eng-26. 17p. (CONF-660934-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA International Survey Course on Economic and Technical Aspects of Nuclear Power, Vienna, Austria.

The techniques and principles involved in an evaluation of fuel cycle costs for light water reactors fueled with slightly enriched UO_2 are discussed. Estimated fuel cycle costs for boiling water reactors based on fabrication costs and warranted performance by the General Electric Company are given as an illustrative example. (H.D.R.)

5629 (ORNL-TM-1647) EXPERIMENTAL DYNAMIC ANALYSIS OF THE MOLTEN-SALT REACTOR EXPERIMENT. Kerlin, T. W.; Ball, S. J. (Oak Ridge National Lab., Tenn.). Oct. 13, 1966. Contract W-7405-eng-26. 58p. (CONF-661001-28). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Dynamics tests were performed on the MSRE for the full range of operating power levels to determine the power-to-reactivity frequency response. Three types of input disturbances were used: the pseudo-random binary reactivity input, the pulse reactivity input, and the step reactivity input. The frequency response of the uncontrolled reactor system displayed resonant behavior in which the frequency of oscillation and the damping increased with increasing power level. Measured periods of natural oscillation ranged from thirty min at 75 kW to two min at 7.5 MW. These oscillations were lightly damped at low power, but strongly damped at higher power. The measured results generally were in good agreement with predictions. The main conclusion is that the system has no operational stability problems and that the dynamic characteristics are essentially as predicted. (J.R.D.)

5630 (RT-FIMA-(66)-1) SOLUZIONE NUMERICA DELLE EQUAZIONI DELLA CINETICA DI UN REATTORE NUCLEARE. (Numerical Method for Integrating Reactor Kinetic Equations). Casadei, G.; Fucci, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 15p. Dep. mn.

A numerical method for integrating the reactor kinetic equations is shown with the usual space-independent assumption. Reactivity excess and extraneous sources are supposed time-integrable functions. The density of the ith delayed neutron group precursor is approximated, in each integration step, by a parabolic expression with coefficients depending on differential equations and initial conditions at each step. Numerical integrations, whenever necessary, are performed by the Simpson's rule. (tr-auth)

5631 (RT-ING-(66)-4) IMPIANTO PER LA PROVA IN ORGANICO DEI MECCANISMI DI COMANDO DELLE BARRE DI CONTROLLO. (Organic Tests of Control Rod Mechanisms for Organic Cooled Reactors). Di Chirico, G.; Fabi, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 32p. (In Italian). Dep. mn.

The PRO-BA experimental facilities were used to test with Santowax the prototypes of control rod drive mechanisms for the PRO reactor or for similar organic cooled reactors. The various plant components, the operation modalities, the safety and emergency devices, and the operation tests carried out are described. (auth)

5632 (SL-2317) LARGE TURBINE PERFORMANCE AND TURBINE PLANT COST STUDY. (Sargent and Lundy, Chicago, Ill.). Dec. 1, 1965. Contract W-7405-eng-26. 62p. (ORNL-TM-1641). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Oak Ridge National Lab., Tenn.

Performance data and cost estimates are developed for units employing large condensing and noncondensing turbine generators applicable to large nuclear dual-purpose power and desalination plants. The units studied have capacities ranging from 300 to 750 MW(e) and a variety of steam conditions and cycle arrangements. (H.D.R.)

5633 (UJV-1585) FLAT FLUX SLAB REACTOR AS A CAUCHY'S PROBLEM. Bartosek, V.; Zezula, R. (Ustav Jaderneho Vyzkumu, Ceskoslovenska Akademie Ved, Rez). Aug. 1966. 14p.

Using the qualitative theory of differential equations, the equivalence of the boundary value and the Cauchy's initial value problem is demonstrated for slab flat flux reactor. It is found that there exists an interval of the initial (central) fuel concentrations for which the initial value problem (with two algebraic conditions) describes a critical flat flux reactor while solutions outside this interval describe undercritical systems or nonmultiplying medium. (auth)

5634 PRODUCTION OF FUEL TUBES FOR THE HDR REACTOR. Hoechel, J. (Allgemeine Elektricitaets-Gesellschaft, Grosswelzheim, Ger.); Liebmann, B. Atomwirtschaft, 11: 530-4 (Nov. 1966). (In German).

The extreme operating conditions of the boiling, superheating elements of the HDR place high demands on the concentrically arranged fuel tubes. For the chosen concept the temperature difference between the inner and outer jacket can be 300 to 350°C. By a suitable combination of jacket materials the thermal stress problems can be reduced. Schematic representations of the element and the bundle are presented. Lifetime evaluations were made of fuel elements with steel coatings. (M.C.G.)

5635 REACTOR PRESSURE VESSELS FROM STRESSED CONCRETE. Luks, H. (Kernforschungsanlage, Juelich, Ger.). Atomwirtschaft, 11: 535-40(Nov. 1966). (In German).

The characteristics of steel pressure vessels are reviewed and compared with those of pressure vessels of prestressed concrete. The geometric form of the pressure vessel, concrete technology, and developed pressure vessels of prestressed concrete in the Marcoule G-2 and G-3, the Chinon EDF 3, the Oldbury Nuclear Power Station, and the Wylfa Reactor Station are discussed. (M.C.G.)

5636 DEVELOPMENT OF CONTROL ROD DRIVE MECHANISM AT HITACHI. Ebata, Takeo; Inoue, Tatsunosuke (Hitachi Ltd., Tokyo). Hitachi Hyoron, 47: No. 12, 19-21(Dec. 1965). (In Japanese).

A description is given of some reactor control-rod drives manufactured by Hitachi, Ltd. In a wire drum—electromagnetic clutch type, a stainless steel wire is rolled up or down to raise or lower the control rod by a motor to reactor scram, the rod is dropped by means of the electromagnetic clutch. A screw— and nut—electromagnetic hold type is described. A reluctance motor—hydraulic piston type is installed at the bottom of a reactor and by means of limit switches connected to a synchro—device and lead-switch, the control-rod is moved upward for scram. A screw nut—ball latch type has an induction motor and a servo—motor alternately switch the drive, vary the stroke with a limit device and interlock the rod electrically and mechanically. (NSA of Japan)

5637 THE COMPACT SODIUM-COOLED NUCLEAR REACTOR INSTALLATION AT KARLSRUHE (KNK). PART II. RESEARCH AND TESTING PROGRAM. Harde, R.; Stoehr, K. W. Atomwirtschaft, 11: 448-53(Aug.-Sept. 1966). (In German).

The KNK located on the site of the Nuclear Research Center at Karlsruhe has important technical characteristics for the realization of a fast breeder reactor. Its concept raised numerous problems, whose reliable solution appeared possible only with the help of a comprehensive experimental development and testing program. Zirconium hydride as a moderator as well as a new type of ferritic steel required lengthy metallurgical investigations, manufacturing studies, and irradiation experiments. An extensive technical test program for components and entire installation systems was just as necessary as comprehensive technical safety studies. (tr-auth)

5638 VARIATION OF LOCAL VOID FRACTION IN RANDOMLY PACKED BEDS OF EQUAL SPHERES. Thadani, Mohan C.; Peebles, Fred N. (Univ. of Tennessee, Knoxville). Ind. Eng. Chem., Process Design Develop., 5: 265-8(July 1966).

The distribution of local void fraction in a bed of randomly packed uniform spheres was investigated by the use of a model of a typical pebble bed-type nuclear reactor. The model consisted of a Plexiglas reactor vessel into which plastic spheres were poured. One of the packings was fixed in a plastic matrix, and was segmented. Each segment was radiographed and the point void fractions were determined by photometric reading of the radiograph emulsion point densities. The investigation involved a novel approach to the problem of point void fraction determination. (auth)

5639 CHANGE OF FLUX IN THE VICINITY OF DISTURBANCE IN REGULAR SQUARE LATTICE. Rocek, Jindrich (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Jad. Energ., 12: 322-5(Sept. 1966). (In Czech).

A numerical solution was obtained for a heterogeneous system of equations describing a correct square of infinite lattice in which one block is substituted by a block with different properties. A solution was sought for a cylindrically symmetric system with the symmetry axis in the disturbance block. A zero value at the established cylindrical boundary is assumed. This latter is used for determining the eigenvalue of the system. Several variations of the disturbance block effects on the flux in heavy water-natural U reactor were computed using the method. (R.V.J.)

5640 SOLUTION OF THE PROBLEM OF ANALYTICALLY CONSTRUCTING AN OPTIMAL REGULATOR FOR A NUCLEAR POWER INSTALLATION. Sokolova, N. M. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 21-8(1965). (In Russian).

An optimal-control system for a nuclear installation consisting of a reactor, regenerator, cooler, and turbine compressor is developed. The partial differential equations of the system are reduced to ordinary differential equations by averaging the parameters of the length of the heat exchangers with subsequent establishment of a connection between the average gas temperature and the inlet and outlet temperatures, in the form of a uniformly converging series. Means of designing a programming element that develops the optimal program for the system, and an optimal regulator capable of following the specified program and correcting the operation of the system are discussed. By way of an example, a simple program aimed at maintaining a system in the stationary condition is analyzed mathematically. A similar method can be used to control a specified change in output power, to ensure cooling of the reactor within a minimum time, and other control operations. The connection between the dynamic programming as described in the paper and Lyapunov functions is briefly indicated. (ATD)

5641 ON THE INFLUENCE OF AN EXTERNAL HIGH FREQUENCY SIGNAL ON THE STABILITY OF THE OPERATION OF A BOILING WATER REACTOR. Sergeev, I. P. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 17-20(1965). (In Russian).

An approximate analysis of the change in reactivity due to an external signal, using harmonically linearized equations of the reactor dynamics is presented. An equation is obtained for the power transfer function, as well as equations describing slow changes of the power and of the steam content. Conditions under which self oscillations of power with frequency much lower than the frequency of the external signal arise in the system are determined. It is shown that because of the nonlinearity the effect of feedback is not completely eliminated in the system. Analysis of the conditions for self oscillations shows that a high frequency external signal affects the stability of the reactor, and that the degree and character of this influence are determined both by the amplitude of the signal and by the parameters of the system. Conditions under which the signal causes loss of stability are indicated. The possibility of using a signal to suppress self oscillations in the system and thereby increase the stability is also discussed. It is shown in the conclusion that the method can be used for a two-frequency external signal with large frequency difference, and with allowance of entry of oscillations into the system via the feedback loop. (ATD)

5642 METHOD AND DEVICE FOR LINEARIZING THE CHARACTERISTIC OPERATION CURVE OF CONTROL RODS IN NUCLEAR REACTORS. Aleite, Werner (to Siemens-Schuckertwerke AG). German Patent 1,222,175. Aug. 4, 1966. Filed July 2, 1964.

The height of lift and/or the absorber area of the control rod are matched to the neutron flux in such a way that each step of motion of the control rod effects an equal change in reactivity. (Gmelin)

5643 HETEROGENEOUS NUCLEAR REACTOR. Setzwein, Andreas; Braun, Helmut (to Brown Boveri/Krupp Reaktorbau GmbH). German Patent 1,221,736. July 28, 1966. Filed Jan. 22, 1965.

A nuclear reactor is cooled by vaporization of a liquid flowing through the core and by heating a chemically different gas flowing through separate channels in the core. A mixing drum is arranged above the core in which the heated gas and the vapor are mixed and which is connected to a turbine. The gas-vapor mixture is separated again after its expansion in the turbine and before the components are recirculated through the core. (Gmelin)

5644 VAPOR COOLED NUCLEAR REACTOR. Ritz, Ludolf (to Gesellschaft fuer Kernforschung mbH). German Patent 1,221,735. July 28, 1966. Filed May 11, 1963.

A nuclear power plant comprises a spherical outer containment, a spherical core enclosed within a spherical pressure vessel and located in a shielded pit, spherical vapor generators situated about the said pit, blowers, heat exchangers for the removal of shutdown heat, and two circular manifolds connecting the reactor vessel with the vapor generators. The space within the containment is divided into two halves by a floor, below which the above named reactor parts are situated. The space above the floor contains cranes and stores for flooding the containment in case of danger. (Gmelin)

5645 NUCLEAR REACTOR CONTROL. Mostert, Pieter (to Samenwerkende Electriciteits Productiebedrijven). U. S. Patent 3,261,755. July 19, 1966. Priority date June 4, 1962, Netherlands.

A control system is described which consists of a multiple branched network of tubes extending vertically through the reactor core and closed at the upper end. The tubes are connected to a common supply of a neutron absorbing liquid and contain a gas cushion between the liquid and the closed end of each tube. The neutron flux distribution is varied in any desired manner by regulating the height of liquid in the tubes, which height will in general be different for each tube according to its place in the reactor. (H.D.R.)

5646 BYPASS CONTROL FOR NUCLEAR REACTORS. Kornbichler, Heinz (to Licentia Patent-Verwaltungs-GmbH). German Patent 1,222,939. Aug. 18, 1966. Filed Dec. 3, 1964.

A nuclear reactor from which steam is passed directly to a turbine is provided with two parallel bypass lines bypassing the turbine and delivering the steam load to a condenser connected at the outlet of the turbine. A constant rate of steam flow is maintained during normal operation by connecting the control valves in the two bypass lines to the turbine throttle valve. An additional quick opening valve in one of the two bypass lines is connected to the shut down valve situated upstream of the turbine throttle valve which opens when the steam flow through the turbine is shut off. (Gmelin)

5647 IMPROVEMENTS IN OR RELATING TO FUELS FOR NUCLEAR REACTORS. Murray, Peter; Sayers, John Brian (to United Kingdom Atomic Energy Authority). British Patent 1,042,008. Sept. 7, 1966. Filed June 11, 1963.

A dispersion fuel material suitable for use in a water-cooled reactor consists of a dispersion of mixed Zr and Pu dioxides in an alloy of Zr as the matrix material. Any corrosion resistant alloy suitable for use in pressurized water environs is suitable for use as a matrix material; however, the preferred alloys are those known as "Zircaloys" having a weight composition of 0.25 to 2.5% Sn, 0 to 0.25% Fe, 0 to 0.16% Cr, 0 to 0.08% Ni, and the balance Zr. In the fuel material, the molar ratio of ZrO_2 to PuO_2 is greater than 1, and the total content of mixed oxides in the fuel is up to 40 volume %. (B.L.M.)

5648 IMPROVEMENTS IN OR RELATING TO CONTROL OF LIQUID MODERATED NUCLEAR REACTORS. Hall, Kenneth; Sidoli, Joseph Ernest Antony (to United Kingdom Atomic Energy Authority). British Patent 1,042,382. Sept. 14, 1966. Filed Jan. 10, 1964.

Improvements are patented for a liquid moderated reactor having the reactor core supported in a tank for containing the moderator. A baffle is mounted in the tank below the core and is adapted to retain a volume of pressure gas against a free surface of the moderator within the baffle to support the rest of moderator at a given level below the core. An upwardly extending conduit communicates with the underside of the baffle for releasing pressure gas, and means are provided for indicating the position of the free surface of the moderator within the baffle. The improvements consist of a further upwardly extending conduit and a series of nozzles at the lower end of the conduit. The conduit provides communication between the lower region of the tank beneath the baffle and the atmosphere through which the excess pressure built up under the baffle is relieved if the position of the free surface drops below a certain level. The nozzles at the lower end of the conduit are of varying shape of inlet aperture and are immersed into and beneath the level of the free surface so that an increasing drop in the level of the free surface causes an increasing area of total nozzle inlet area to be exposed to the pressure gas so as to vent the excess gas pressure by way of the conduit and to cause the free surface within the baffle to be restored to its predetermined limit. (B.L.M.)

5649 ORGANIC MODERATED NUCLEAR REACTOR AND CONTROL METHOD THEREFOR. Visner, Sidney (to Combustion Engineering, Inc.). U. S. Patent 3,271,261. Sept. 6, 1966. Filed Dec. 27, 1963.

A design is patented for an organic moderated and cooled power-breeder reactor in which the reactor is controlled by diluting the moderator with a proper diluent. For the organic moderated reactor, the preferred diluent is a fluorocarbon, which is miscible with the coolant moderator, such as a fluoronated diphenyl. (B.L.M.)

5650 PRESSURE-ABSORBING MEANS FOR NUCLEAR REACTOR STATIONS. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 1,042,643. Sept. 14, 1966. Priority date Jan. 24, 1963, Sweden.

A system is described in which the pressure ordinarily released to a partially water filled pressure suppression chamber in the event of a breakdown of a nuclear reactor is exhausted to the atmosphere. The pressure medium is led from the reactor proper in under the water level of the partially water-filled enclosure. The air volume above this water level is in communication with at least one other chamber but is isolated from the second chamber by a liquid lock. The second chamber is separated from the atmosphere by a membrane, and a pressure absorbing means is interposed between the membrane and the open air. (B.L.M.)

5651 NUCLEAR REACTORS. Jeffries, Thomas Oliver; Long, Everett; Smyth, Robert Walter (to The English Electric Co. Ltd.). British Patent 1,042,315. Sept. 14, 1966. Filed Oct. 10, 1962.

A reactor control system is comprised by one single walled tube or several such tubes, at least a part of which is contained in the reactor core and which contains a neutron absorbing gas, the source of which is outside the reactor core. The tube is closed except for a single inlet/outlet passage communicating with the source of neutron-absorbing gas. Pressure-varying means are arranged to vary the pressure of the gas in that portion of the tube within the reactor core in response to changes in conditions in the reactor so as to cause corresponding changes in the rate of neutron absorption by the control gas to nullify changes in reactor conditions. The source of gas comprises a pair of reservoirs arranged to contain the control gas under substantially different pressures with valve means sensitive to the neutron flux and the temperature of the coolant leaving the core arranged to connect the reservoirs separately to that portion of the tube within the core either to add gas or to remove gas. (B.L.M.)

5652 FUEL ELEMENT FOR A NUCLEAR REACTOR. (to Oesterreichische Studiengesellschaft fuer Atomenergie GmbH). British Patent 1,047,654. Nov. 9, 1966. Priority date Apr. 26, 1963, Austria.

A fuel element for use in a nuclear reactor adapted to operate in a low or high temperature range and designed to prevent the contamination of the reactor coolant by fission products consists of a nuclear fuel substance embedded in a matrix that comprises a sintered material and a number of additives capable of reaction with various fission products to bind them into the matrix. The fuel material may be shaped and treated in various ways to produce the desired shaped fuel element. The additives are selected from substances such as the elements Ag, Ta, Mo, Be, Si, Se, Zr, and compounds, such as carbides, of these elements. The fuel substance is present in a powder, ball, or particulate form; and the sintered material in which the fuel is embedded may take a variety of geometric shapes. (B.L.M.)

5653 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Kramers, William Julian; Smith, James Raymond; Bradshaw, Walter; Sinden, Roland Perce; Rogers, Philip Sydney (to United Kingdom Atomic Energy Authority). British Patent 1,042,011. Sept. 7, 1966. Filed Oct. 14, 1958.

A solid fuel, fluid cooled reactor is patented that employs as fuel and at least part of the moderator a chemically combined compound suitable for use at high temperatures in the reactor. The chemical material is made up of either ^{233}U, ^{235}U, ^{239}Pu, ^{2}H, or ^{3}H as the fuel held in chemical bond by a refractory compound comprised of a metal and non–metal combined to form a metal–non–metal crystal lattice. The non–metal comprises either N_2, O_2, C, ^{1}H, ^{2}H, or ^{3}H. The preferred fuel for the reactor is cerium plutonium hydro–oxysulfide. The fuel may be used in the usual forms, such as canned, compacted, or pelletized. Either conventional control means may be used to control the reactor, or it may be controlled by steel tubes containing a material made up of a refractory compound composed of a rare earth metal of low capture cross section; a rare earth selected from the group consisting of Eu, Gd, or Sm; a non-metal, such as N_2, O_2, or C; and ^{1}H. A typical compound for control means is cerium samarium hydro–oxysulfide. (B.L.M.)

5654 NUCLEAR REACTOR FUEL ASSEMBLIES. Robinson, John Albert; Cooke, Brian Frederick (to Nuclear Power Plant Co. Ltd. A.E.I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 1,039,204. Aug. 17, 1966. Filed Mar. 11, 1964.

A coupling device is provided for nuclear fuel assemblies of the type in which a cluster of sheathed rods of fuel are disposed with their axes generally parallel within a closed graphite tube and which are commonly stacked one upon the other in the fuel channel of a gas cooled reactor. The rod is formed in a number of separate sections coupled together to permit limited relative axial and angular movement between adjacent sections. The sections have collars associated with them in such a way that an axial movement of the sections as the result of the application of a lifting force to the rod, the lifting force is transmitted to the graphite tubes of the fuel assemblies. The separate sections of the rods are coupled together by means of projections on the end of one section engaging a recess formed in the end of an adjacent section. (B.L.M.)

5655 PROCESS FOR HANDLING ASSEMBLIES OF FUEL ELEMENTS IN A NUCLEAR REACTOR COOLED BY AN OPAQUE LIQUID. (to Societe Belge pour l'Industrie Nucleaire). British Patent 1,048,620. Nov. 16, 1966. Priority date Jan. 15, 1964, Belgium.

A method is patented for handling assemblies of fuel elements in reactors cooled by opaque liquids in which the level of the liquid is caused to descend below the heads of the assemblies so as to allow visual examination of the handling operation. An indirect examination may be effected by means of mirrors, television cameras, or other like means. Provision is made for the continued circulation of coolant inside the core of the reactor and in the fuel assemblies during the handling operation. Preferably, the heads of the assemblies that are to be handled by a gripping device are sufficiently apart from the bodies of the elements to avoid the need for very precise regulation of the level of cooling liquid and to avoid surface eddies when the liquid leaves the assemblies during the handling operations. (B.L.M.)

5656 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Sulzer Freres, Societe Anonyme). British Patent 1,041,714. Sept. 7, 1966. Priority date June 7, 1962, Switzerland.

A method is described for the operation of a nuclear reactor that includes control means dependent both upon the temperature of the circulating coolant leaving the reactor and upon the load on the reactor. The control means controls the flow of coolant circulating through the reactor. The temperature determining means is arranged to supply a signal to a safety device, which in the event of the temperature exceeding an adjustable critical level, influences the control system to reduce the reactor power output. (B.L.M.)

5657 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Wootton, William Robert (to Babcock and Wilcox Ltd.). British Patent 1,041,773. Sept. 7, 1966. Filed Dec. 29, 1961.

A liquid moderated, heterogeneous reactor is patented that includes a core chamber having a core that becomes critical when only partly immersed. The level of the liquid moderator is varied in accordance with variations in the power output of the plant. The regulation of the level of the moderator in the core chamber is effected by pressure variations in a vapor space of the core chamber so that an increase in pressure within the vapor space effects depression of the level of the moderator and a decrease in pressure in the vapor space effects an increase in the level of the moderator. (B.L.M.)

5658 NUCLEAR REACTORS. Pearson, Robin (to The Nuclear Power Plant Co. Ltd. and A.E.I.–John Thompson Nuclear Energy Co. Ltd.). British Patent 1,041,709. Sept. 7, 1966. Filed Aug. 18, 1964.

A dividing wall structure is provided between the hot and cool gas compartments of gas cooled reactors that will withstand differential thermal expansions due to temperature gradients across the wall and will provide support for the tubular extensions and adequate sealing of the spaces surrounding the tubular extensions as they pass through the wall. The wall structure comprises a grid member through which pass the tubular extensions from the channels of the hot gas compartment of the reactor. The tubular members are located at the intersections of the grid members with cover plates located on the tubular members and disposed over the openings in the grid members. The cover plates have openings in them to permit the passage through them of the tubular extensions. Sealing means are located between adjacent cover plates to prevent the leakage of gas between the plates but to allow relative lateral expansion between the plates. A thermal insulating layer also is disposed on the hot gas side of the compartment. (B.L.M.)

5659 IMPROVEMENTS IN OR RELATING TO THE CONTROL OF NUCLEAR POWER PLANTS. Taylor, Anthony James (to Babcock and Wilcox Ltd.). British Patent 1,041,221. Sept. 1, 1966. Filed Feb. 8, 1962.

A nuclear reactor plant includes a reactor; a forced flow, once through boiler; and means for circulating coolant in heat exchange relationship with the nuclear reactor core and the boiler and has first and second control adapted to respectively adjust the reactivity of the reactor core and to adjust the operating fluid feed flow to the boiler. The first responsive means is responsive to a temperature established by the coolant of the nuclear reactor or to a function of that temperature and is arranged to adjust one of the control means in dependence upon changes in the temperature condition. The second responsive means is responsive to the pressure of vapor generated in the boiler and is arranged to adjust the other of the control means in dependence upon changes in the pressure. (B.L.M.)

5660 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Shaw, Richard Arthur; Walton, Gilbert Northcott (to United Kingdom Atomic Energy Authority). British Patent 1,048,590. Nov. 16, 1966. Filed Nov. 19, 1962.

A method is patented to prevent the diffusion of Pu through the sheath wall of a nuclear fuel element in which the U metal is encased in a sheath material, such as Magnox ZR55, by interposing an interlayer between the uranium and the sheath. The fuel element has its ends closed by end caps, and further interlayers are provided between each end cap and the corresponding end faces of the members of nuclear fuel material. The interlayer(s) may be produced as a coating or film on the fuel member or on the inner surface of the sheath and end caps or both. The coating may be of graphite sprayed or painted on as a suspension of graphite in alcohol or of magnesium chromate. (B.L.M.)

5661 CONTROL SYSTEM. Kuerzel, Robert Edward (to General Electric Co.). British Patent 1,043,271. Sept. 21, 1966. Filed May 20, 1963.

A control arrangement is provided for a single cycle power system for rapidly varying the motive fluid output from the motive fluid generator in response to system load changes. The system which includes a motive fluid generator, a turbine, and power control means for setting the output power level from the generator in accordance with the speed of the turbine is particularly applicable to systems that include boiling moderator-coolant type nuclear reactors. The control system includes speed responsive means responsive to the speed of the turbine and pressure responsive means responsive to the pressure in the generator. The speed responsive means are connected operatively to the pressure responsive means to set a base pressure for the generator in accordance with the speed, and the pressure responsive means are connected operatively to valve means for varying the flow of motive fluid from the generator to the turbine in accordance with pressure changes in the generator to maintain the base pressure in the generator. (B.L.M.)

5662 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Dahlgren, Joens Arthur. British Patent 1,043,500. Sept. 21, 1966. Priority date Sept. 16, 1964, Sweden.

A nuclear reactor system employing a pressurized water reactor is patented in which only a small portion of the pressurized water is circulated to a liquid-liquid type heat exchanger where it gives up its heat. This primary exchanger is connected in series to a superheater which operates with a gaseous fluid and has a large heat exchanging surface. This system allows the small primary exchanger which is expensive to build to be held to a minimum size and therefore to a minimum cost. The large superheater is not in contact with the pressurized water and can be constructed of much less expensive materials. (B.L.M.)

5663 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Emsley, George Michael; Bradshaw, Arthur Jeffrey (to Nuclear Power Plant Co. Ltd. A.E.I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 1,038,983. Aug. 17, 1966. Filed Mar. 26, 1963.

A design is patented for a bar shaped reactor fuel element housed in a container of similar shape and provided with fins on two opposing faces. The fins are inclined with respect to the longitudinal axis of the element; and the container is provided with edge portions, which are hollow and which have surfaces that lie in planes containing the tips or portions of the fins adjacent to the tips or in planes adjacent to but beyond the fin tips. This arrangement obviates or largely overcomes the possibility of damage to the fins. (B.L.M.)

5664 IMPROVEMENTS IN OR RELATING TO THE CONTROL OF NUCLEAR REACTORS. Cawthra, Frank (to Atomic Power Constructions Ltd.). British Patent 1,045,261. Oct. 12, 1966. Filed July 17, 1961.

A method for control of a gas-cooled reactor comprises monitoring the coolant gas outlet temperature, comparing that temperature with a standard temperature, and deriving an electric signal representing the variation of the coolant temperature from the standard temperature. Recurring control signal pulses whose polarity and duration are representative of the variation at the time of occurrence of the control signal pulses are derived from the electric signal. The reactor control rods are adjusted by means of synchronous control rod driving motors which are switched off and on by a device responsive to the duration and polarity of the control signal pulses. The system may be so modified to permit independent control of individual sectors of the reactor. (B.L.M.)

5665 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Wolfenden, Bryan; Hart, David Frederick (to United Kingdom Atomic Energy Authority). British Patent 1,042,320. Sept. 14, 1966. Filed Dec. 27, 1962.

To prevent elongated fuel elements stacked in fuel channels and held in position by a mating cup and cone arrangement from sticking together under conditions of high temperatures and irradiation, the engaging parts are composed of two different materials. The cone-engaging surface of the cup at one end of the fuel element is composed of metallic material. The cone at the other end of the fuel element is made in two portions that are secured together. One portion, constituting the cup-engaging portion of the cone is made of a refractory material, such as graphite, magnesia, or alumina; and the other portion, constituting the body portion of the cone for securing the cup-engaging portion to the fuel element, is made of a magnesium base alloy. (B.L.M.)

5666 METHOD OF OPERATING A GAS-FLUIDIZED NUCLEAR POWER REACTOR AND REACTOR FOR CARRYING OUT THE METHOD. Steenbeck, Max (to VEB Atomkraftwerk Rheinsberg mit Betriebsteil Berlin). German Patent 1,228,008. Nov. 3, 1966. Filed Dec. 8, 1959.

A nuclear reactor is described in which solid particles of fuel are fluidized by a gas circulated through a primary circuit including the core and heat-exchangers. The core is composed of moderator bodies provided with channels through which the gas-fluidized fuel is passed. A device controls the concentration of the fuel within the core by varying the flow of the gas. In order to prevent the sedimentation of fuel in the reactor part of the gas is branched off the primary circuit, passed through a compressor, and reintroduced into the primary circuit at points where the fuel tends to deposit. (tr-auth)

5667 NUCLEAR REACTOR WITH JET PUMP ARRANGEMENT FOR OBTAINING FORCED LIQUID CIRCULATION. Kierulf, Birger Christian; Westrum, Thoerbjoern (to Institutt for Atomenergi). U. S. Patent 3,274,065. Sept. 20, 1966. Priority date May 18, 1962 and Mar. 27, 1963, Norway.

A method for obtaining forced circulation of a liquid in thermodynamic systems of nuclear reactors, vapor generators, and heat pumps is presented. Injector devices similar to the feed water injection nozzles of steam boilers are suggested. For further improvement of the circulation of a liquid used as coolant and moderator, the water jet pump principle is advanced. (J.C.W.)

5668 GAS-COOLED NUCLEAR REACTOR. Bremer, Ferdinand (to Beteiligungs- und Patentverwaltungsgesellschaft mbH). German Patent 1,226,720. Oct. 13, 1966. Filed May 15, 1965.

In a gas-cooled nuclear reactor the core and the heat exchangers are positioned within a containment with a single access. The heat exchangers, which are circularly arranged around the core, are mounted on wheels whereby they are moved in front of the access for repairing purposes. (Gmelin)

Marine and Portable Power Reactors

5669 (NYO-3370-4) EVALUATION OF PM COLLETS: CONTROL ROD DRIVE MECHANISM STUDY. PHASE I. Engineering Memorandum No. 3474. Hagen, O.; Sherwood, Don (Westinghouse Electric Corp., Cheswick, Pa. Atomic Equipment Div.). June 18, 1965. Contract AT(30-1)-3370. 209p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

The control rod actuators on the PM-1 and PM-3A power plants use collets to lock the control rods to the actuators. The collets had deformed after a period of use. Theoretical and test evaluations reveal that the deformation was due to high scram loads. That is, the collet design, in terms of material selection, configuration, and mode of loading could not sustain the g loads imposed by the buffer system design. The loads deformed a test collet made from AISI 304 SST but did not noticeably deform a test collet made from tempered AISI 410 SST material. (auth)

5670 COMPETITION POSSIBILITIES FOR ATOMIC MERCHANT SHIPS. Steinert, C.; Braun, W.; Oldekop, W. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Atomwirtschaft, 11: 435-42(Aug.-Sept. 1966). (In German).

The competitive price of a nuclear ship is determined to the order of magnitude on the basis of a parameter study under certain assumptions for unknown cost factors such as installation cost, reactor cost, part cost, etc. It is shown that nuclear ships can be competitive for a main propulsion system size of 50,000 SHP and at high speeds. This holds especially for large ships and perhaps for container ships. (tr-auth)

5671 ECONOMIC OPERATION OF NUCLEAR ENERGY SHIP PROPULSION SYSTEMS. von zur Muehlen, M. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg). Atomwirtschaft, 11: 442-3(Aug.-Sept. 1966). (In German).

Remarks are given to a previous study of the competitiveness of atomic merchant ships. The question of whether the commercial ship owners will need for their ships such propulsion systems to which nuclear energy is competitive, as well as the still existing uncertainty of installation costs of ship reactors are considered. (tr-auth)

Rocket and Space Reactors

Refer also to abstracts 4989 and 5598.

5672 (NAA-SR-11934) FINAL SNAPSHOT PERFORMANCE REPORT. Berg, G. E. (Atomics International, Canoga Park, Calif.). Aug. 15, 1966. Contract AT(11-1)-Gen-8. 289p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An evaluation of overall system and individual component performance during all phases of the flight test is presented for SNAP 10A. In the evaluation special emphasis is placed on maximizing the amount of information obtained regarding the effect of the launch and space environments on the operation and performance of a nuclear thermoelectric system. In general the in-flight data agree with ground test results or extrapolation of those results to space. (J.R.D.)

5673 (NASA-SP-131, pp 147-68) SNAP-8 DEVELOPMENT STATUS. Slone, Henry O. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.).

The development of the SNAP-8 power system using a mercury Rankine cycle is described. The system will produce a minimum electric power of 35 kW and will operate unattended for 10,000 hrs. The system includes a nuclear reactor, power conversion system, and a flight radiator assembly. Research completed on the reactor and power conversion systems is summarized. (F.S.)

5674 NUCLEAR ENERGY FOR SPACE IN THE USSR. Veselsky, J. C. Atomwirtschaft, 11: 454-7(Aug.-Sept. 1966). (In German).

The development of the high-temperature reactor Romaschka and of atomic batteries by the Soviet Union for space is treated. Comparisons are made with American systems. (L.B.S.)

Process Heat and Desalination Reactors

Refer also to abstracts 4648, 5608 and 5632.

5675 (ORNL-TM-1618(Pt.1)) NUCLEAR DESALINATION DUAL-PURPOSE PLANT CONTROL STUDIES. Interim Report. Ball, S. J. (Oak Ridge National Lab., Tenn.). Oct. 1966. Contract W-7405-eng-26. 79p. Dep. mn. CFSTI $3.00 cy, $0.75 mn.

Methods were developed for predicting the dynamic behavior of a large dual-purpose plant consisting of a pressurized-water reactor (PWR), a back-pressure turbine generator plant, and a multistage flash (MSF) evaporator. A flexible digital computer code was developed which calculates the transfer functions for single-effect MSF plants. Preliminary results were obtained for a 250-megagallon reference plant and some of the major control problems were determined. An analog computer study was made of a reference PWR plant, and transfer functions for a large back-pressure turbine were derived. (auth)

5676 DISTILLATION OF SEA WATER EMPLOYING NUCLEAR ENERGY. Pedrick, Arthur Paul. British Patent 1,042,541. Sept. 14, 1966. Filed Apr. 12, 1965.

A method is described for distillation of sea water by pumping a stream of sea water over the outer surface of a nuclear reactor, which is mounted for rotation and provided with screw blades so that the flow of the sea water maintains the reactor in rotation. The heat energy from the reactor is transferred to the sea water by conduction causing the sea water to boil. The steam so produced is guided to a condenser. During the rotation of the reactor, the scraper blades remove deposits of salt resulting from the boiling of the sea water. The reactor is described for particular application to "floating fields" described in British Patent 1,038,320 and which would be maintained in an area, not necessarily far from the coastline, but at a sufficient distance not to provide any form of radiation hazard to inhabitants of the local area. (B.L.M.)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 5597 and 5598.

5677 (AE-250) THE INTERACTION BETWEEN CONTROL RODS AS ESTIMATED BY SECOND-ORDER ONE-GROUP PERTURBATION THEORY. Persson, R. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Oct. 1966. 45p. Dep. mn.

The interaction effect between control rods is an important problem for the reactivity control of a reactor. The approach of second-order one-group perturbation theory is shown to be attractive due to its simplicity. Formulas are derived for the fully inserted control rods in a bare reactor. For a single rod a correction parameter b is introduced, which with good approximation is proportional to the strength of the absorber. For two and more rods an interaction function $g(r_{ij})$ is introduced which is assumed to depend only on the distance r_{ij} between the rods. The theoretical expressions are correlated with the results of several experiments in R0, ZEBRA, and the Agesta reactor, as well as with more sophisticated calculations. The approximate formulas are found to give good agreement with exact values, but in the case of about 8 or more rods higher-order effects are important. (tr-auth)

5678 (AECL-2606) LATTICE MEASUREMENTS WITH 28-ELEMENT NATURAL UO_2 FUEL ASSEMBLIES. PART I. BUCKLINGS FOR A RANGE OF SPACINGS WITH THREE COOLANTS. Serdula, K. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). July 1966. 95p. Dep. mn. AECL $2.00.

Bucklings derived from activation measurements in the ZED-2 reactor are given for 28-element natural UO_2 fuel assemblies. Measurements were made in D_2O-moderated triangular arrays of 55 assemblies at pitches in the range 20 to 40 cm. The three coolants used were D_2O of moderator purity, He to simulate a voided condition, and HB-40, an organic liquid. Bucklings obtained with He as coolant are greater than those for D_2O and HB-40 coolants for the pitches investigated. Macroscopic variations of the In−Cd ratio were measured with D_2O and organic coolants within the range of pitches studied. (auth)

5679 (AERE-R-5183) DETERMINATION OF THE FAST-NEUTRON SPECTRUM IN THERMAL REACTORS BY USING ^{6}Li AND ^{3}He SEMICONDUCTOR SPECTROMETERS. Silk, M. G. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1966. 56p. Dep. BIS $1.20. HMSO 8s.

A ^{6}Li-loaded sandwich type semiconductor neutron spectrometer was used to determine fast-neutron spectra in the low-power reactors DAPHNE, LIDO, and GLEEP. The spectrum from a Pu−Be fast-neutron source has been studied. The resultant spectra are shown to be in good agreement with spectra calculated by Monte Carlo techniques and with spectra obtained by other workers. The sources of error in, and the potential application of, this method of neutron spectrometry are considered. (auth)

5680 (ANL-7158) FARET CONTROL ROD DRIVE MECHANISMS. Hutter, E.; Sullivan, T. E.; Giorgis, G. D. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 36p. Dep. mn. CFSTI $3.00 cy, $0.65mn.

FARET was designed to be a 50-MW(t) sodium-cooled fast reactor experimental facility. Twelve control drives, operating above the reactor vessel, but inside of a large shielded cell, were to move 12 poison control rods over a 24-in. vertical distance. The control drives are electromechanical devices, that include pneumatic scram accelerators and hydraulic decelerators. A gripper mechanism at the lower end is submerged in 1150°F sodium and is remotely controlled to grip or to release a control rod. The detailed design of the control drive cluster, its operating characteristics, and preliminary tests of some control drive components are described. (auth)

5681 (BAW-3647-1) PHYSICS VERIFICATION PROGRAM. Quarterly Technical Report No. 1, January–June 1966. (Babcock and Wilcox Co., Lynchburg, Va.). Aug. 1966. Contract AT(30-1)-3647. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements are described of the nuclear properties of water-moderated, slightly enriched U-fueled lattices, perturbed by boric acid and Ag−In−Cd control pins. Three critical assemblies were studied in this period. In all cases the lattices consisted of 0.475-in.-OD rods of 2.46%-enriched UO_2, arrayed on a square pitch of 0.644 in. and moderated by H_2O. Only the boric acid concentration in the moderator (and the critical dia) was changed, from zero to about 1.5 g B/l. The critical conditions, reactivity coefficients ($\Delta\rho/\Delta h$ and $\Delta\rho/\Delta N_B$), buckling, and thermal disadvantage factor are reported. Methods being developed for the measurement of ρ_{28}, the modified conversion ratio, and the epithermal neutron spectrum are described. (auth)

5682 (BNWL-308) FAST FLUX TEST FACILITY. ADOPT: PROGRAM FOR STEADY-STATE PROCESS DESIGN AND COST OPTIMIZATION OF FFTF HEAT REMOVAL SYSTEMS USING HEAT DUMPS TO AIR. Goss, C. L.; Johnson, H. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1966. Contract AT(45-1)-1830. 218p. Dep. mn. CFSTI $6.00 cy, $2.00 mn.

ADOPT, a computer program, was developed to provide process design and cost optimization data for the Fast Flux Test Facility's heat removal systems using an air heat dump. Complete sizing and cost data are calculated for the intermediate heat exchanger, dump heat exchanger complex, primary loops, and secondary loops for a given set of input, process, and basic equipment design data. (auth)

5683 (BNWL-SA-909) FAST FLUX TEST REACTOR: CRITICAL EXPERIMENTS PROGRAM. Bennett, R. A.; Hofmann, P. L.; Little, W. W.; Maas, L. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 22, 1966. Contract AT(45-1)-1830. 29p. (CONF-661019-3). Dep. mn. CFSTI $2.00 cy, $0.50 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

The purpose of the high-intensity Fast Flux Test Facility (FFTF) is to provide irradiation testing to support fuel and material development for the fast breeder power reactors. The high-intensity Fast Flux Test Facility and the Fast Test Reactor (FTR) are being designed. The complexity of the facility and the difficulties and costliness of late design changes make it necessary to assure a sound basis for nuclear design. The phases of the program are scoping of critical experiment program, planning, and performance and analysis of critical experiments. The results of the scoping effort are presented. (V.C.W.)

5684 (CEA-R-3048) FLUX DE NEUTRONS RAPIDES DANS LES PILES A EAU LOURDE. (Fast Neutron Flux in Heavy Water Reactors). Brisbois, Jacques; Katz, Shlomo L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). July 1966. 45p. Dep. mn.

The possibility of calculating the fast neutron flux in a natural uranium−heavy water lattice by superposition of the individual contributions of the different fuel elements was verified using a monodimensional Monte-Carlo code. The results obtained are in good agreement with experimental measurements done in the core and reflector of the reactor AQUILON. (tr-auth)

5685 (GA-6178) GAS-COOLED REACTOR EXPERIMENTAL EXCURSION TEST. Final Report on Feasibility Studies, August 1, 1964-January 31, 1965. Stern, M.; Baxter, A.; Dahlberg, R.; Melese, G.; Merrill, M.; Thompson, W. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Mar. 15, 1965. Contract AT(10-1)-205; Subcontract C-261. 119p. Dep. mn. CFSTI $4.00 cy, $0.75 mn.

For General Dynamics Corp., San Diego, Calif. General Atomic Div.

A program is described involving the development of a Graphite Reactor Experimental Excursion Test facility to study subjects pertinent to the safety of solid moderator reactors. The reasons why experimental safety studies of high temperature gas-cooled reactors should be undertaken are presented. Suggested test cores forming the first part of a proposed experimental program are described. A three-stage minimum program is outlined which should yield data valuable for the design of future advanced high-temperature gas-cooled reactor systems. The experimental facility requirements are described. Core structure, core cooling and heating, control rod systems, facility requirements, radioactivity problems, and experimental instrumentation are considered. The compatibility of these requirements with the existing SPERT II facilities is discussed. (auth)

5686 (GA-6178(Suppl.1)) GAS-COOLED REACTOR EXPERIMENTAL EXCURSION TEST. Supplement No. 1 to Final Report on Feasibility Studies. Stern, M. O.; Baxter, A.; Dahlberg, R.; Merrill, M.; Thompson, W.; Zumwalt, L. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 8, 1965. Contract AT(10-1)-205; Subcontract C-261. 31p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

For General Dynamics Corp., San Diego, Calif. General Atomic Div.

The GREET test program is being designed to provide basic data as well as prototype or engineering data. Basic data refers to information developed to check or improve theoretical models. Prototype or engineering data means information which is used in the engineering design and/or evaluation of nuclear power plants. The possibility of obtaining basic types of data, notably Doppler coefficient information, from Stage 3 of the GREET test program is examined. The reactor systems which could be studied in the GREET facility are reviewed. A general discussion is included concerning GREET experiments which would yield information of importance to the safeguards evaluation of graphite moderated gas-cooled reactors. (J.C.W.)

5687 (GA-6178(Suppl.2)) GAS-COOLED REACTOR EXPERIMENTAL EXCURSION TEST. Supplement No. 2 to Final Report on Feasibility Studies. Stern, M. O.; Baxter, A. M.; Dahlberg, R. C.; Thompson, W. I. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). July 6, 1965. Contract AT(10-1)-205. 42p. Dep. mn. CFSTI $2.00 cy, $0.50 mn.

For General Dynamics Corp., San Diego, Calif. General Atomic Div.

Methods proposed to obtain moderator−coefficient data and Doppler−coefficient data at high temperatures such as those reached in some reactor accidents are discussed. The possibility of complementing the GREET program with experiments in other facilities is also discussed along with the accuracy with which Doppler and thermal-base coefficients can be computed. (J.R.D.)

5688 (IS-1448) DETERMINATION OF FAST NEUTRON SPECTRA IN A HEAVY WATER REACTOR USING NUCLEAR EMULSIONS. Youngblood, Jimmie R. (Ames Lab., Iowa). Sept. 1966. Contract W-7405-eng-82. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Nuclear emulsions have been exposed in the core of the Ames Laboratory Research Reactor to obtain the fast neutron flux spectrum (.8 to 5.0 MeV). It is found that the spectrum is generally similar to the Watt fission spectrum but with the peak shifted upward in energy to as high as 2.3 MeV. Superimposed on this are small depressions and peaks corresponding to the resonances and anti-resonances in the cross section of oxygen. Also, a theoretical approach to obtaining the neutron spectrum independent of experiment has been developed. (auth)

5689 (JUL-343-RE) VORUNTERSUCHUNGEN ZU DEM GEPLANTEN IMPULSREAKTOR-PROJEKT DER KERNFORSCHUNGSANLAGE JUELICH. (Preliminary Investigations on the Planned Impulse Reactor Project of the Juelich Nuclear Research Center). Biedermann, D.; Kraemer, H.; Kalker, K. J.; Thamm, G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Feb. 1966. 205p. Dep. mn.

Pulse reactions in operation are described. The proposed experimental program in the design of a pulse reactor at the Juelich Research Center is outlined. The reactor parameters are described and it is shown that these specifications require that the fuel element be a matrix with a solid moderator of BeO or graphite and low fuel concentration. BeO appears to be a more suitable carrier than the graphite. The results of numerical nuclear and flux calculations are given. Previous studies on the kinetic behavior of pulse operation and an analysis of the reactivity in the release of rectangular pulses are given. The thermodynamic behavior of the fuel matrix in gas and water cooling and under various fuel element constructions are studied. Some consideration is given to the reactor building, the experimental devices, and the reactor hall. (J.S.R.)

5690 (JUL-361-RG) DAS BRUTVERHALTEN EINES EPITHERMISCHEN SALZSCHMELZENREAKTORS. III. EXTERNE KUEHLUNG DURCH BLEI (NACHTRAG). (The Breeding Ratio of an Epithermal Fused Salt Reactor. III. External Cooling by Lead (Supplement)). Barthold, W. P.; Graf, I.; Wolf, L. A. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Mar. 1966. 70p. Dep. mn.

The breeding behavior of an intermediate fast fused salt installation (MOSEL-molten salt epithermal reactor) with external cooling by lead was investigated. The core melt consists of $NaF-ZrF_4$ + UF_4. The effect of ZrF_4 substituted for BeF_2 in the original breeding studies was determined. The effect of various concentrations of $^{28}UF_4$ and ThF_4 and the influx of the core volume on the breeding behavior were also considered. (tr-auth)

5691 (NASA-TN-D-3709) MEASUREMENT OF EFFECTIVE DELAYED NEUTRON FRACTION FOR NASA ZERO POWER REACTOR I. Alger, Donald; Mayo, Wendell; Mueller, Robert (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1966. 37p. CFSTI $3.00 cy, $0.65 mn.

The effective delayed neutron fraction β_{eff} has been experimentally determined for each of three $UO_2F_2-H_2O$ solution reactors in the NASA ZPR-I facility. The H to ^{235}U atom ratios R for the solutions in these measurements are 190, 473, and 565. The value of β_{eff} has been measured by the B substitution method. Values for β_{eff} obtained are 0.0090 ± 0.0006, 0.0086 ± 0.0005, and 0.0082 ± 0.0004 for the respective atom ratios. Calculated values of β_{eff} are in reasonable agreement with the experimental results. (auth)

5692 (ORNL-P-2641) CRITICAL EXPERIMENTS WITH A MOCK-UP OF THE REPETITIVELY PULSED REACTOR SORA. Kistner, G.; Mihalczo, J. T. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 11p. (CONF-661019-8). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From International Conference on Fast Critical Experiments and Their Analysis, Argonne, Ill.

A series of critical experiments has been performed on a close mock-up of the SORA reactor. SORA is a NaK-cooled, repetitively pulsed fast reactor which will be used as a high intensity neutron source for time-of-flight experiments. The reactivity of this reactor is periodically varied by means of a movable reflector. Those parameters which are related to the kinetics of the reactor have been investigated thoroughly in the critical experiments. The total reactivity value of the movable reflector determines the ratio of the peak power to that between pulses. The reactivity of the movable reflector as a function of its position and the prompt neutron decay constant determine the half width of the neutron pulses. These parameters have been measured for Be and for Fe reflectors of several sizes and for various core and reflector configurations. (auth)

5693 (ORNL-TM-1662) PSEUDO-RANDOM BINARY SIGNAL FOR FREQUENCY RESPONSE TESTING. Kerlin, T. W. (Oak Ridge National Lab., Tenn.). Sept. 23, 1966. Contract W-7405-eng-26. 55p. Dep. mn. CFSTI $3.00 cy, $0.50 mn.

The characteristics of a pseudo-random test signal were examined to evaluate it as a tool for frequency response testing in nuclear reactors. The frequency characteristics of the pseudo-random signal were determined. This required an evaluation of the dependence of the relative amplitudes of the harmonics on the number of binary bits in the sequence and the duration of each bit. Two types of data analysis were investigated. One is the indirect method, which requires autocorrelation of the input signal, cross-correlation of input and output signals, and subsequent Fourier analysis. The other is the direct method, involving filtering, squaring, cross multiplying, and time averaging of the signals. The error owing to improper selection of analysis frequencies was determined for both methods. Results of pseudo-random binary tests made on the Molten-Salt Reactor Experiment are included. These results support the theoretical conclusions. (auth)

5694 (ORNL-TM-1678) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, JANUARY-MARCH 1966. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Oct. 24, 1966. Contract W-7405-eng-26. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ORR operated at an average power level of 29.9 MW for 94% of the time during the report period. Downtime required by experimenters was minimal and unscheduled downtime totaled less than one-half hour. The slight problem with shim-rod vibration reported the previous quarter diminished, and instrument performance in general was quite good. One shim-rod-drive assembly was removed for a routine inspection. No excessive wear or corrosion was found. Work was begun on alterations to the piping pit at the primary pump house in preparation for turning the 24-in. reactor-primary-inlet valve to the safer horizontal position. Several Be reflector pieces were measured to determine the extent of neutron damage, which appears as bending or bowing. A calibrated slide-bar and dial indicator specially adapted for hot cell use was utilized for these measurements. Previous estimates of the rate of damage were confirmed, and the data indicate that the Be-management program will be effective in preventing excessive loss of Be through damage. (auth)

5695 (TID-23415) PRELIMINARY ASSESSMENT CALCULATIONS ON THORIUM-URANIUM-HEAVY WATER SYSTEMS. Nitteberg, J. (Institutt for Atomenergi, Kjeller (Norway)). May 1966. Contract AT(30-1)-3498. 14p. (NC-75). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The METHUSELAH code is used to calculate the reactivity and conversion ratio of three Th-U-heavy water systems, one uniform lattice system and two cluster systems. The enrichment in ^{235}U oxide, the moderator-to-fuel volume ratio, and the fuel pellet diameter are varied. The results show small differences in reactivity between the three lattice types, while the conversion ratio is highest for the uniform lattice. The reactivity increases and the conversion ratio decreases with increasing enrichment and fuel to moderator volume ratio in the parameter range studied. Both the reactivity and conversion ratio are little sensitive to the fuel pellet diameter variation performed. (auth)

5696 MATRIX WITH POSITIVE ELEMENTS AND THE CRITICALITY OF A NUCLEAR REACTOR. Marek, Ivo. Pokroky Mat. Fys. Astron., 11: 121-34(1966). (In Czech).

Development of matrices which can have only positive elements and their application to the problems of criticality of nuclear reactors are described. An analysis is presented concerning the basic boundary problem of reactor physics, the requirement of non-negativity and its meaning for the solution of operational equations, the application of the matrix to the calculation of criticality of nuclear reactors, and the application of the method of iteration of the source. The concept of Perron for operators in Banach space, the classical matrix theory, and the concepts of Banach and Hilbert space are used. It is stated that the goal of the article is to show an example of the way in which the classical theory of matrices with positive elements is generalized to fit the requirements of a physical situation. (TTT)

5697 THE SORA PROJECT IN STAGE READY FOR CONSTRUCTION. Ritter, G. (EURATOM, Ispra, Italy). Atomwirtschaft, 11: 417-20(Aug.-Sept. 1966). (In German).

The progress and the present state of development on the fast pulsed SORA reactor for the Euratom Research Center at Ispra are reported. (L.B.S.)

5698 USE OF OSCILLATION TESTS TO INVESTIGATE FLUX TILTING. Foulke, Larry R.; Gyftopoulos, Elias P. Massachusetts Inst. of Tech., Cambridge). 7p. (CONF-660606–51). ORAU. Gmelin, AED-CONF-66-203-89.

From American Nuclear Society Meeting, Denver.

Small amplitude oscillation tests are used to measure certain modal eigenvalues and it is shown that the eigenvalues may be used to infer the susceptibility of a power reactor to flux tilting. A relation is given for the dynamics of the reactor representing all the group fluxes, delayed neutron precursors, feedback variables, and matrix operators corresponding to the initial and perturbed reactor states. The relation between flux tilting and the relative magnitudes of the prompt neutron eigenvalues is shown. (J.C.W.)

5699 BEAM TUBE FOR A RESEARCH REACTOR. Mueller, Arno; Kostrzewa, Siegfried H.; Hamburger, Hermann (to Deutsche Babcock and Wilcox-Dampfkessel-Werke). German Patent 1,221,368. July 21, 1966. Filed July 27, 1961.

The beam tube comprises a stepped shielding plug, an elongated, closed beam hole in the axis of the tube and piercing the plug, a radiation window at the end of the beam hole adjacent to the reactor core, and means for flooding the beam hole with a liquid. The liquid within the beam hole and a sliding lead shutter shield the experimental facilities against the radiation from the reactor core. In order to prevent air bubbles from entering the beam hole in flooding, the liquid is introduced at one end of the beam hole and flows out at the other end. (Gmelin)

Production Reactors

5700 (DP-1071) ACTIVITY CONFINEMENT SYSTEM OF THE SAVANNAH RIVER PLANT REACTORS. Durant, William S.; Milham, Robert C.; Muhlbaier, David R.; Peters, Albert H. (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1966. Contract AT(07-2)-1. 145p. Dep. mn. CFSTI $4.00 cy, $1.00 mn.

A filtration-adsorption system is installed in the ventilation exhaust of each reactor building at the Savannah River Plant for confinement of airborne particulate and I_2 vapor activity that might be released in the event of a reactor accident. Air from the process areas of each building is passed continuously through moisture separators, then through particulate filters, and finally through I_2 adsorber beds of activated carbon. The system has the experimentally demonstrated ability to confine more than 99% of airborne particulate activity and more than 99.9% of airborne halogen activity, even with allowance for methyl iodide, under emergency conditions that could exist following a reactor accident. A mechanism for methyl iodide formation was developed from published data for general application to reactor confinement. Under Savannah River Plant conditions, less than 0.0001% of the total I_2 inventory in the reactor would be converted to methyl iodide. (auth)

Reactor Components, Fuels and Accessories

Refer also to abstracts 4895, 4908, 4909, 4921, 4999, 5014, 5015, and 5017.

5701 (JINR-P-2828) STATISTICHESKAYA MODEL TOCHECHNYKH DVUKHZONNYKH REAKTORNYKH SISTEM. (Statistical Model of Point Two-Zone Reactor Systems). Kozik, B.; Li Khon Seb (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1966. 14p. Dep. mn.

The correlation theory of neutrons in two-zone systems is considered as well as the conditions under which the formulas of the point reactor model can be applied. (tr-auth)

5702 (NAA-SR-Memo-11860) BOILING SODIUM HEAT TRANSFER. Noyes, R. C.; Lurie, H. (Atomics International, Canoga Park, Calif.). Feb. 23, 1966. Contract AT(11-1)-Gen-8. 11p. (CONF-660819-1). ORAU.

From 3rd International Heat Transfer Conference and Exhibit, Chicago, Ill.

Boiling Na heat transfer was investigated experimentally under forced-convection and free-convection conditions. Cylindrical test sections of essentially identical geometry were used in both types of experiments. Measurements of heat transfer rates and surface temperatures were made at subatmospheric pressures and at heat fluxes up to 1.6×10^6 Btu/hr-ft^2. Pool boiling heat transfer coefficients were in fair agreement with the Forster-Zuber predictions; forced convection results indicated approximate agreement with the superposition hypothesis. Pool-boiling critical heat flux (CHF) was found to be a very weak function of pressure. The dependence of forced-convection CHF on pressure, flow, and subcooling or vapor fraction was found to generally agree with qualitative trends for other fluids. (auth)

5703 (NAA-SR-Memo-11936) GAS ENTRAINMENT IN THE SCTI SECONDARY SODIUM SYSTEM. Turner, G. E. (Atomics International, Canoga Park, Calif.). Apr. 29, 1966. Contract AT-11-1-GEN-8. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tests showed that at Na flow rates greater than about 1700 gpm, gas is entrained at the steam generator free surface and is transported to the secondary expansion tank. Some of the gas also remains in circulation throughout the secondary system. The rate of gas transport to the expansion tank and the amount of gas in circulation both increase rapidly with Na flow until system instability is reached at a Na flow of about 2700 gpm with the steam generator level control at its normal setting. Increasing the steam generator level control setpoint to its practical maximum increases the point of system instability to about 3200 gpm and keeps gas entrainment rates reasonable up to about 2800 gpm Na flow. This is sufficient to allow performance of all planned tests except the reduced superheat operation. (auth)

5704 (NAA-SR-Memo-11987) ANALYSIS OF SAFETY AND RELIEF VALVE INSTALLATIONS IN THE SCTI SECONDARY STEAM AND BOILERFEED LINES. Bonyhady, K. A. (Atomics International, Canoga Park, Calif.). May 23, 1966. Contract AT-11-1-GEN-8. 18p. DTIE.

Safety valve installations in the secondary steam lines and relief valve installations in the boilerfeed lines of the Sodium Component Test Installation are analyzed and improvements are proposed. A stress analysis is included for each proposed improvement. (H.D.R.)

5705 (ORNL-P-2391) DESIGN OF A REMOTE SYSTEM FOR FABRICATION OF $(Th\text{–}^{233}U)O_2$ METAL-CLAD FUEL ELEMENTS. Sease, J. D.; Pratt, R. B.; Davis, F. C.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 21p. (CONF-661001-24). DTIE.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

A major portion of the design of a remote fabrication system for fabricating metal-clad oxide-containing fuel elements by the bulk oxide, vibratory compaction, mechanical assembly route was completed. The process equipment was designed to operate on a pilot-plant scale of 40 rods per 8-hr shift in the Th-U recycle facility. The major objective was to establish economics and unit processing times that would be amenable to a full-scale production plant. The design approach, the equipment layout in the cell, and a description of each piece of process equipment are given. (auth)

5706 (UCRL-14986) COMPARISON OF TWO FUEL ELEMENT SHAPES. Walter, Carl (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 31, 1966. Contract W-7405-eng-48. 18p. (CONF-661001-35). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Externally-cooled fuel pins and internally-cooled fuel tubes are compared for otherwise identical reactors. The fuel tube design overcomes the deficiency of the fuel pin design as regards fission gas pressure venting. Fuel tubes have lower material ΔT and thermal stress than fuel pins. A greater number of smaller fuel tubes is required to replace fuel pins. (auth)

5707 MATERIALS AND TESTING PROBLEMS FOR NUCLEAR REACTORS. REPORT OF THE DVM COLLOQUIUM IN JUELICH. Ullrich, W. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main); von der Decken, C. B. Atomwirtschaft, 11: 557-9(Nov. 1966). (In German).

Steel, concrete, and graphite in reactor construction were considered in the Colloquium of the German Association for Materials Testing at the Juelich Nuclear Research Center, April 28 and 29, 1966. (M.C.G.)

5708 TEMPERATURE MEASUREMENTS IN NUCLEAR REACTORS. Krivtsov, V. A.; Gushchin, G. I.; Frakmovnikova, A. A. Teplofiz. Vysok. Temp., 4: 279-81(Mar.-Apr. 1966). (In Russian).

A brief review is given of the methods for reactor temperature measurements and for determination of nuclear radiation effects on temperature transducer materials. The studies established that thermocouples are the most suitable temperature transducers for nuclear reactors, especially, chromel–alumel thermocouples which have high thermoelectrical stability in a radiative field. Thermometers may be used in nuclear reactors for short times or in external switch boards. Pyrometers are suitable only at very high temperatures which are above the thermocouple capacity. (R.V.J.)

5709 LOCKING MECHANISM FOR A CONTROL ROD. Handel, Hubert; Braun, Helmut; Landwehr, Heinz (to Brown, Boveri/Krupp Reaktorbau GmbH). German Patent 1,226,224. Oct. 6, 1966. Filed May 28, 1965.

The locking mechanism consists of bolts attached to and protruding from the control rods and of two control plates positioned one above the other. The horizontal movement of the plates is mechanically coupled in such a manner that they move simultaneously by substantially the same distance in opposite directions to each other on moving the control rods. (Gmelin)

5710 NUCLEAR FUEL ROD ASSEMBLY. Hazel, Victor E.; Zeller, John J. (to U. S. Atomic Energy Commission). U. S. Patent 3,281,328. Oct. 25, 1966.

A patent is described relating to a fuel element assembly of fuel rods for a nuclear reactor. Pairs of flexible spacer devices formed as open triangles and having nodular loops at each corner are fitted over a central fuel rod and then rotated 60° with respect to each other. Individual fuel rods are arranged in the space between corners of the rotated spacer devices. The fuel rods assembled with the spacer devices are arranged in a generally cylindrical liner which is provided with retainer means at 60° radial spacing into which the nodular loops fit when the fuel rod and spacer device assembly is rotated within the liner. (auth)

5711 SEAL FOR A CONTROL ROD APPARATUS. Hutter, Ernest; Sullivan, Thomas E. (to U. S. Atomic Energy Commission). U. S. Patent 3,280,002. Oct. 18, 1966.

A patent is described concerning an arrangement for permitting rapid movement of a control rod in a reactor while retaining effective sealing. A compound sealing construction has one portion sealing the control rod in its withdrawn position during reactor operation and another portion sealing the control rod in its inserted position at reactor shutdown and yet has no sealing action during the very short period needed for rapid insertions of the control rod for shutdown of the reactor. This absence of sealing during the rapid insertion enables the rapid insertion to occur. (auth)

5712 MINIMIZING THE EFFECTS OF FLUX GRADIENT IN A REACTOR. Hennig, Robert J. (to U. S. Atomic Energy Commission). U. S. Patent 3,281,325. Oct. 25, 1966.

A patent relating to a nuclear fuel element is described that is mounted in a reactor so that it rotates about its longitudinal axis and is so shaped that coolant flowing through or over the fuel element rotates it about its longitudinal axis. Rotation of the fuel element equalizes the neutron flux to which the fuel element is subjected during reactor operation. (auth)

5713 DEVICE FOR MONITORING SHUT-DOWN NUCLEAR REACTORS. Antal, Emil F.; Brons, Charles D.; Quinlan, Frank B.; Ostrom, S. J. (to U. S. Atomic Energy Commission). U. S. Patent 3,276,969. Oct. 4, 1966.

A patent is described relating to a safing wire or band for installation in a nuclear reactor to detect operation of the reactor. The device is a metal matrix containing a target material which becomes radioactive in the event of a neutron chain reaction and integral therewith a random array of bodies of a different metal forming a pattern not subject to reproduction to identify the safing wire or band. (auth)

5714 CONTROL MECHANISM FOR NUCLEAR REACTORS. Challender, Ronald Scott (to Societe Anglo-Belge Vulcain). German Patent 1,227,574. Oct. 27, 1966. Filed Dec. 24, 1964.

A control mechanism is described that is composed of a hollow piston integral with the reactor vessel, the lower part of which includes a second piston provided with a shutter constituting a safety expansion valve. The valve has an aperture into which water is injected at a pressure higher than that of the atmosphere surrounding the mechanism for pushing the piston against the action of the spring, closing the safety valve and opening the apertures located above the valve. The compressed water passes through the apertures and lifts the absorbent double-wall cylinder out from the core, against the action of the spring, to bring the reactor to the critical state. (Gmelin)

5715 ELECTROMAGNETIC APPARATUS FOR MOVING AN ABSORBING ROD IN A NUCLEAR REACTOR. Moisel, Peter (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,227,573. Oct. 27, 1966. Filed Mar. 24, 1962.

The linear electromagnetic apparatus for moving the absorbing rod longitudinally comprises a plurality of mover coils disposed side by side along the rod which are energized for moving and partially de-energized for holding the rod in a predetermined cycle. For partially de-energizing the coils the current through each of them is reduced by connecting two neighboring coils in series. (Gmelin)

5716 DEVICE FOR MONITORING THE STRUCTURAL CONTINUITY OF THERMALLY INSULATING LAYERS IN NUCLEAR REACTORS. Becker, Winfried; Finzi, Sergio; Jorzik, Ernst R.; Ohlmer, Eggert (to EURATOM). German Patent 1,227,164. Oct. 20, 1966. Filed June 24, 1965.

The structural continuity of a thermally insulating layer disposed between the sheath of a nuclear reactor fuel element and the wall of a pressure tube surrounding this fuel element is monitored by means of an electrical cable wrapped around and in close contact with the pressure tube. A pulse generator and an oscillograph are connected to the cable. Hot spots are detected by displaying pulses on the screen of the oscillograph which are reflected between the two ends of the cable. (Gmelin)

5717 METHOD OF ERECTING THE CONTAINER OF A NUCLEAR REACTOR UNDERGROUND. Janner, Karl (to Siemens-Schuckertwerke Aktiengesellschaft). German Patent 1,227,162. Oct. 20, 1966. Filed June 9, 1962.

The container is assembled at the surface of the earth, transferred through a shaft and mounted in an underground cavity, the diameter of shaft being smaller than the dia of the cavity and of the container at its underground destination and in its final stage of erection. In order to facilitate the transport of the container through the shaft the container is assembled above ground in such a way that its dia is smaller than the dia of the shaft. In the cavity the container volume is increased to its desired size either by expanding the walls or by smoothing out indentations in the walls. (Gmelin)

5718 REACTOR CONTROL ROD DRIVE MECHANISM. Dufrane, Kenneth H. (to Martin Marietta Corp.). U. S. Patent 3,278,385. Oct. 11, 1966. Filed June 4, 1964.

A reactor control rod drive mechanism is given providing fully remote operation, maximum reliability and zero leakage at high differential pressures over 10,000 psi. The control system presented is simple in construction and inexpensive to manufacture. (J.C.W.)

5719 BRACES FOR FUEL ELEMENT CLUSTERS. Thome, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,278,388. Oct. 11, 1966. Priority date May 22, 1963, France.

Fuel elements for nuclear reactors cooled by a thermal fluid are described in this patent. The fuel element is an assembly of clad fuel rods arranged in parallel forming a cluster held in position by support grids. The braces are placed at mid-length of the rods to maintain constant the section of passageway provided for thermal fluid and to increase mechanical strength of the assembly. (J.C.W.)

5720 NUCLEAR FUEL ELEMENT. Heiers, Wilhelm; Leipold, Michael (to EURATOM). German Patent 1,222,592. Aug. 11, 1966. Filed July 1, 1964.

The sheath of a nuclear fuel element having a rectangular cross section is provided with an end cap which can be separated from the sheath by means of remote handling equipment. The force-locking connection of the end caps with the end of the sheath is achieved by spring loaded members attached to the caps and arranged to press radially outward onto the sheath and to snap into suitable recesses in the sheath on mounting. (Gmelin)

5721 BOILING REACTOR WITH SUPERHEAT. Setterwall, Max (to Allmaenna Svenska Elektriska Aktiebolaget). German Patent 1,225,315. Sept. 22, 1966. Priority date Sept. 7, 1962, Sweden.

The reactor comprises a core, a guide and support structure constituting a closed vessel and arranged above the core, a steam dome arranged above the closed vessel, first tubes for generating steam and second tubes for superheating the steam generated in the first tubes each arranged with part of its length in the reactor core and part of its length in the closed vessel. The first tubes have outlet ports at their upper end above the closed vessel, and the second tubes which are closed at their upper ends have inlet ports for the steam in the parts arranged within the closed vessel. At least one steam channel having an inlet port arranged above the outlet ports of the first tubes in the steam dome accomplishes the communication of the steam dome with the interior of the closed vessel and the second tubes. (Gmelin)

5722 CONTROLLED UNLOADING OF GEOMETRICALLY ORDERED PACKED BEDS. Susskind, H.; Becker, W. W.; Maresca, M. W. (to U. S. Atomic Energy Commission). U. S. Patent 3,294,645. Dec. 27, 1966.

A nuclear fuel assembly consisting of a bed of spherical fuel particles provided with nozzles for selectively fluidizing the bed for the removal, rearrangement, and replacement of the particles is described. Selective fluidization makes it possible to remove the particles in a predictable and orderly manner. (AEC)

5723 PHOTONEUTRON MONITOR FOR DETECTING REACTOR FUEL ELEMENT FAILURES. Dexter, A. H.; Lapsley, A. C. (to U. S. Atomic Energy Commission). U. S. Patent 3,293,434. Dec. 20, 1966.

A method and apparatus for detecting failed fuel elements in a nuclear reactor are described. A sample of the coolant or blanket gas which has been held a sufficient length of time to permit decay of short lived isotopes is passed through a duct extending through a body of material which reacts with the radiation to be detected to produce neutrons. The neutrons produced in the body of material are detected by an instrument positioned in an instrument well extending into the body of material. (AEC)

5724 DELAY BED SYSTEM FOR PURIFICATION OF NUCLEAR FUEL ELEMENT PURGE STREAM. French, James E.; Steyer, Keith G.; Wessman, George L. (to U. S. Atomic Energy Commission). U. S. Patent 3,278,386. Oct. 11, 1966.

A system is described for maintaining the relative purity of the coolant stream of a high temperature, gas-cooled nuclear reactor. A purge stream which has flowed through a fuel element is directed through a delay bed comprising a series of adsorbent portions and heat exchangers. Each adsorbent portion is preceded by a heat exchanger of sufficient capacity to cool the fission product-laden gaseous stream to less than 200°F prior to entry into the adsorbent portion, and the adsorbent portion contains a permeable substance of high Xe adsorption capacity, the quantity such that the heat produced by decay of radioactive isotopes delayed by continued adsorption and desorption on the substance does not raise the temperature of the stream beyond 450°F. The total number of adsorption portions is sufficient to delay the major portion of ^{137}Xe a sufficient time to decay to plateout daughters ^{137}Cs and ^{137}Ba. (auth)

5725 FUEL ELEMENT. Trickett, Kenneth A.; Simnad, Massoud T.; Malek, George J. (to U. S. Atomic Energy Commission). U. S. Patent 3,291,699. Dec. 13, 1966.

A patent is described relating to a nuclear reactor fuel element having an elongated tubular body section which is formed of refractory material and which has a cylindrical support member disposed longitudinally within it. The support member forms a plurality of recesses in which nuclear fuel compacts are disposed. A layer of material disposed between the nuclear fuel compacts and the support member accommodates thermal expansion and irradiation growth. (AEC)

5726 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTORS. Harde, Rudolf; Brandstetter, Amandus; Stoehr, Karl-Walter (to Interatom). German Patent 1,226,222. Oct. 6, 1966. Filed Oct. 22, 1964.

The fuel element assembly comprises an elongated casing structure, through which the reactor coolant is passed, a bundle of fuel rods mounted within the casing and laterally spaced from each other, and close-packed rods of metallic hydride within the casing for moderating purposes, which surround the fuel rods. (Gmelin)

5727 LIQUID-COOLED NUCLEAR REACTOR FUEL ELEMENT. Rische, Ernst; Karlsen, Erich (to Interatom). German Patent 1,226,221. Oct. 6, 1966. Filed Oct. 12, 1960.

The fuel element consists of a bundle of fuel rods positioned within a common container through which the coolant is passed and which is provided with a tubular foot of reduced cross section in relation to the cross section of the container. The dia of the foot, the lower open end of which is set into an opening in the base plate of the core, is calibrated in such a way that the buoyancy is less than the weight of the fuel element, thus preventing the lifting of the fuel element by the streaming liquid. (Gmelin)

5728 FUEL ELEMENT FOR NUCLEAR REACTORS. Delpeyroux, Paul; Gauthron, Maurice (to Commissariat a l'Energie Atomique). U. S. Patent 3,278,389. Oct. 11, 1966. Priority date Jan. 21, 1964. France.

A fuel element for gas-cooled reactors is described having integral centering splitters wherein each splitter terminates at a distance short of the end of the fuel element of the same order as the distance to which the splitters extend from the can. The terminal portions of the splitters are given a progressively decreasing height to achieve a curved shape. Another proposal is given with the integral centering splitters. Each is divided into separately deformable sections by means of at least one radial cut which extends in depth at least to the level of the fin tips. (J.C.W.)

5729 NUCLEAR FUEL ELEMENT. Kornbichler, Heinz (to Licentia Patentverwaltungs-GmbH). German Patent 1,228,007. Nov. 3, 1966. Filed May 30, 1962.

The element consists of two concentrically arranged tubular sheaths. A nuclear fuel mass is disposed within the annular space between the two sheaths and end caps close the ends of the annular space which are secured in position at the ends of the sheath by sealing welds. The inner and outer sheath as well as the end caps or part of them are composed of different materials. (tr-auth)

5730 COUPLING MECHANISM FOR NUCLEAR REACTOR FUEL ELEMENTS. Wolter, Hans-Juergen (to Gesellschaft fuer Kernforschung mbH). German Patent 1,217,513. May 26, 1966. Filed May 12, 1964.

A nuclear reactor serviced from below has a lower supporting grid plate for releasably supporting the fuel elements in the core. Spring-loaded latching levers pivotally mounted on the grid plate are adapted to engage the upward end of a fuel element holding rod, each of which is provided with an inwardly facing operating extension. The upper end of the holding rod is provided with circumferential indents with outwardly extending upper shoulders which will engage the operating extensions of the levers, and outwardly extending lower shoulders which will disengage the levers from the holding rod by moving them outward into positions of disengagement. (auth)

5731 APPARATUS FOR REMOVING SPENT FUEL ELEMENTS FROM A NUCLEAR REACTOR. Deacon, David (to The English Electric Co. Ltd.). British Patent 1,042,017. Sept. 7, 1966. Filed Dec. 28, 1961.

An apparatus for the removal of spent fuel elements from a gas cooled reactor consists of a duct arranged to contain the gas under pressure and having two valves spaced apart in the duct by a distance greater than the length of the fuel elements. Each valve is arranged for independent operation and comprises a valve housing, which encloses a valve chamber having a continuous peripheral side extending in a direction parallel to the axis of the adjacent portion of the duct. The valve chamber also has two parallel flat sides perpendicular to the axis. Each flat side has a port and the duct is in communication with each valve chamber through the port(s). A flat-sided gate member is movable in the valve chamber between an open and closed position with at least one flat side of the gate member being in continuous parallel contact with a corresponding flat side of the valve chamber. At least one resilient sealing ring is disposed in an annular groove in each flat side of the valve chamber encircling the corresponding port so as to form a sliding seal between the corresponding flat side of the gate member and the valve chamber. Various embodiments of the basic design are described in detail. (B.L.M.)

5732 NUCLEAR REACTORS. Hopkins, John Stirton; Cooke, Brian Frederick (to The Nuclear Power Plant Co. Ltd. and A.E.I.–John Thompson Nuclear Energy Co. Ltd.). British Patent 1,041,307. Sept. 1, 1966. Filed Mar. 17, 1964.

A structure for storage of irradiated fuel elements removed from a nuclear reactor consists of an inner wall structure of nuclear radiation shielding material, which defines the storage pond, and an outer wall structure of a shielding material surrounding and spaced from the inner wall. The outer wall has spaces in it for services dealing with contaminated material, components, and equipment. The structure may form an integral part of a building housing the reactor. (B.L.M.)

5733 NUCLEAR REACTOR VIEWING SYSTEM. Cooper, Richard C. U. S. Patent 3,265,584. Aug. 9, 1966. Filed Nov. 13, 1963.

A safe and reliable high quality optical viewing system for observation of the interior of a nuclear reactor consists of a fiber optic bundle extending from the exterior face of the reactor through the shielding to the interior. The fibers are undulated through the shielding so that a straight line cannot be extended from the interior face of the bundle through the bundle to the exterior face. The inner end portion of the bundle is flexible and free to move, and shifting means are provided for this inner end of the bundle. Control means extend from the shifting means through the shielding to the exterior of the reactor to allow selected movement of the interior bundle face from outside the reactor. (B.L.M.)

GENERAL

5734 (ANL-7125) CHEMICAL ENGINEERING DIVISION SEMIANNUAL REPORT, JULY–DECEMBER 1965. (Argonne National Lab., Ill.). May 1966. Contract W-31-109-eng-38. 246p. Dep. mn. CFSTI $6.00 cy, $1.25 mn.

Eight sections are included; separate abstracts were prepared for each. (P.C.H.)

For abstracts of individual sections see: 4433, 4479, 4480, 4590–4592, 5483, and 5598.

5735 (BNWL–317) ELECTRICAL ANESTHESIA TECHNIQUES. Wilbur, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1966. Contract AT(45-1)-1830. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An attempt to clarify the terminology and to correlate the work of many investigators in electrical anesthesia is presented. Topics discussed are basic definitions of electrical sleep, narcosis, and anesthesia; electronics; electrodes; and physiological responses. (B.G.D.)

5736 (LA-3620) NOTE ON A CLASS OF AMPLITUDE MODULATION DETECTORS. Washburn, Beverly W. (Los Alamos Scientific Lab., N. Mex.). Jan. 14, 1964. Contract W-7405-eng-36. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An analysis of a carrier system amplitude modulation detector of the synchronous class is presented. The analysis is performed by the introduction of a technique wherein the carrier time function is multiplied by a switching function and this product is resolved into the various frequency and error components of interest. Certain switching function asymmetries, carrier harmonics, carrier and switching function phasing, certain systematic errors and additive noise in the carrier are considered. General design recommendations are included. (auth)

5737 (RFP–734) ABSTRACT OF BEARING DEVELOPMENTS AND DATA ON SPINDLES. Green, H. S.; Rains, A. E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Nov. 4, 1966. Contract AT(29-1)-1106. 30p. (CONF-660922–2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 7th International Machine Tool Design and Research Conference, Birmingham, England.

The history of the development of bearings and spindles since the early 19th century, and causes of bearing failures are discussed. Comparisons are given of the different types of bearings which can be used to complement the spindle and classification terminology and ratings are explained and illustrated. Information is also presented on contemporary measurement definitions and bearing nomenclature; gaging practices associated with bearings; and typical high-accuracy bearing specifications. (F.S.)

5738 (Y–1568) MINIATURIZED RADIOTELEMETRY DEVICE FOR MONITORING TEMPERATURES. Pipes, E. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Dec. 13, 1966. Contract W-7405-eng-26. 42p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Technological advancements in telemetry circuits and components, especially in the field of miniaturization, provide means of measuring variables under conditions which have formerly been considered impractical or impossible. The technical aspects of a biotelemetry system for measuring the temperature of a small mammal without the use of restraining wires, and a radiotelemetry system for measuring the temperature of a moving machine member or work-piece. (auth)

5739 THE GERMAN–FRENCH HIGH-FLUX REACTOR INSTITUTE PROJECT IN GRENOBLE. Maier-Leibnitz, H. (Technische Hochschule, Munich). Atomwirtschaft, 11: 427-8 (Aug.-Sept. 1966). (In German).

The most recent international project in atomic research is the German–French High-Flux Reactor Institute, which is to be directed by a German and located in the French Nuclear Research Center at Grenoble. It is intended to serve pure research and to be a crystallization point of international collaboration. A small nearby institute in Munich will facilitate the collaboration of German scientists with Grenoble. Later participation by other countries in the project is possible. In each case visiting scientists could carry out studies. The training of personnel could also be carried out. (tr-auth)

5740 DISMISSAL OF EURATOM? Atomwirtschaft, 11: 406-16(Aug.-Sept. 1966). (In German).

The problems concerned with the present situation and future developments of the European community are considered. The aims, actions, and problems dealing with resources and authority given to Euratom have great significance for the German atomic energy development. Fundamental questions are raised concerning the uncertainty of the consolidation of the European commissions and of the continuation of the second research program in the next year. (tr-auth)

5741 QUASI-STATIC THEORY OF A CYLINDRICAL IMPEDANCE PROBE FOR MAGNETOPLASMA. Wait, James R. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). Radio Sci., 1: 1297-1301(Nov. 1966).

An expression for the fields of two parallel line charges in an anisotropic medium is derived. To facilitate the analysis, the line sources are assumed to be encased in a cylindrical dielectric rod. The result is used to obtain a formula for the driving-point impedance of the device. It is shown that the resonances are a well-defined function of the plasma and cyclotron frequencies. (auth) r